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THE GEOGRAPHIC DISTRIBUTION OF CEREBRAL HEMORRHAGE AND HYPERTENSION IN JAPAN

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IN Japan, tuberculosis was the most outstanding cause of death for a long time, but since 1951 cerebral hemorrhage has taken its place. This seems very different from the situation in Occidental countries where heart diseases are the chief causes of death. Both cerebral hemorrhage and heart diseases, however, are caused mostly by the same high blood pressure.

Hashimoto and others ('33) report that hypertension is by no means rare among urban Japanese among whom it is found nearly as frequently as among Americans or Europeans, as against almost all reports of other areas in the Far East which indicate a low mean blood pressure. In rural Japan, also, it is well known that there are geographic differences in the prevalence of hypertension; it is generally high in the prefectures of the northeast part of the main island. We have studied blood pressures especially of farm-villagers in such prefectures

as Aomori and Akita. It is well-known in this country that the latter have the highest death rate from cerebral hemorrhage in all Japan.

In the present paper the geographic distribution of death rates from cerebral hemorrhage in middle age is described. We find that the middle-age death rate is the most appropriate one to investigate in respect to geographic distribution of cerebral hemorrhage in Japan,

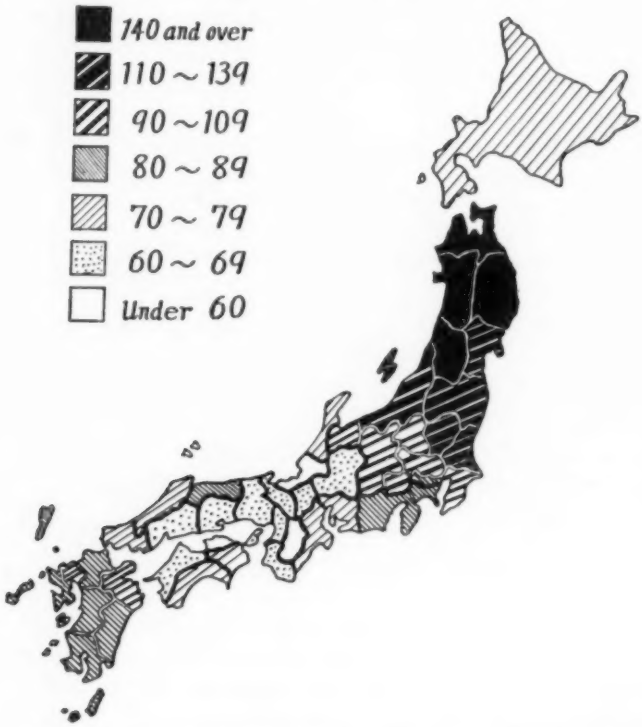

FIG. 1. DISTRIBUTION OF MIDDLE AGE (30–59 YEARS) DEATH RATE FROM CEREBRAL HEMORRHAGE BY PREFECTURES IN JAPAN, 1950, MALE.

especially in the field of public health. In older age classes the death rate is naturally higher, and the proportion of population over 60 years varies considerably among different provinces; therefore, if the population studied contains the older age group also, the death rate may vary with the proportion of older people. In younger age classes cerebral hemorrhage usually has other origins than so-called essential hypertension, especially in the newborn where it comes from birth injury; younger ages are therefore also excluded from consideration.

There are, unforunately, few reliable data, classified by sex and age classes, on the mean blood pressure or the prevalence of hypertension in various populations of different provinces. Though there is voluminous data on average blood pressure of holders of insurance policies for Japan as a whole, we have compared our own data mainly with the results of other local studies.

FIG. 2. DISTRIBUTION OF MIDDLE AGE (30–59 YEARS) DEATH RATE FROM CEREBRAL HEMORRHAGE BY PREFECTURES IN JAPAN, 1950, FEMALE.

GEOGRAPHIC DISTRIBUTION OF CEREBRAL HEMORRHAGE AND HYPERTENSION IN JAPAN

In figures 1 (male) and 2 (female) the geographic distribution of cerebral hemorrhage per 100,000 persons aged 30 to 59 is plotted. The data is listed under "vascular lesions affecting central nervous system" —international abbreviated list number, B22—in the governmental Vital Statistics for 1950. The death rate is calculated for each of the 46 administrative prefectures into which Japan is divided.

TABLE 1

Blood pressure of different provinces in Japan, Male (averages and standard deviations)

NO.	PREFECTURE, KIND OF SUBJECTS	OBSERVERS	YEARS, SEASON	NUMBER		AGE CLASS, YEARS 20–29	30–39	40–49	50–59	60–69	70–79
1.	Hokkaido, Farm villagers	Sakuma	1948 Summer	235	Systolic	122.8± 9.7	128.9±10.5	133.7±10.9	142.9±13.1		
2.	Hokkaido, Farm villagers	Otokozawa	1952	195	Systolic	123.2±10.2	126.6± 9.4	133.8±10.6	143.6±11.2		
3.	Hokkaido, Postal service workers	Maruyama	1953	893	Systolic	129.1±14.6	128.1±14.1	131.3±17.5	138.9±24.7	143.9±22.8	
4.	Aomori, Farm villagers	Takahashi, Sasaki, Takeda and Ito	1954 Summer	307	Systolic	128.3±12.5	130.2±12.2	136.4± 8.6	139.9±21.9	163.1±33.2	165.5±26.2
					Diastolic	68.6±11.6	76.5±11.4	80.1±12.0	82.2±15.5	92.0±18.7	89.0±19.1
5.	Akita, Farm villagers	Takahashi, Sasaki, Takeda and Ito	1955 Summer	286	Systolic	131.9± 9.8	140.0±19.5	144.5±25.1	158.6±28.6	163.8±27.9	180.0±31.0
					Diastolic	67.3±11.2	75.5±14.6	80.7±17.7	90.1±16.3	89.8±14.6	92.5± 8.3
6.	Akita, Farm villagers	Takahashi, Sasaki Takeda and Ito	1955-1956 Winter	204	Systolic	137.7±10.1	145.4±26.9	157.9±29.0	173.3±28.0	175.2±33.3	186.7±37.1
					Diastolic	66.8±13.4	79.4±15.9	87.3±15.2	93.5±16.4	93.1±16.9	101.7±18.9
7.	Akita, Farm villagers	Fukuda *et al.*	1951-1953 Summer	2082	Systolic	131.8±15.2	132.9±15.5	140.8±24.4	152.6±29.0	161.8±28.7	165.0±29.6
					Diastolic	78.4±13.9	81.8±13.5	86.9±17.5	94.2±17.6	96.0±17.9	95.1±17.7
8.	Aomori and Akita (partly), Postal service workers	Araya	1955 Summer	566	Systolic	119.4±13.1	123.1±11.2	132.0±21.5	137.1±22.4	146.4±25.0	
9.	Chiba, Farm villagers	Donomae and Matsumoto	1943 Summer	A 490	Systolic	131.1±15.2	132.3±13.1	140.6±18.8	144.4±23.8	160.5±26.8	163.7±26.6
				B 663	"	122.4±13.2	124.2±14.5	126.5±16.0	132.7±24.5	145.2±29.2	149.4±25.6
				C 311	"	120.7±19.1	124.3±11.3	126.9±18.4	137.0±20.3	146.2±34.9	166.4±26.1
10.	Tittori, Farm villagers	Nishimura *et al.*	1946 Summer	185	Systolic	110.1	104.4	110.9	105.2	120.2	
					Diastolic	58.4	57.8	65.6	61.6	66.0	
11.	Okayama, Farm villagers	Ōshima	1954 Summer	235	Systolic	104.0±10.5	105.0±15.5	109.2±12.2	121.7±28.3	124.8±24.5	
					Diastolic	60.1± 9.0	61.3±11.1	68.3±10.6	75.0±14.4	75.4±10.7	

Notes: Hokkaido is the northern island; Aomori and Akita Prefecture are north, Chiba is middle east, Tottori and Okayama are west in the main land, Kagoshima is south in Kyushu. Numbers following ± mean standard deviation of blood pressure. Average blood pressure of nos. 7 and 10 is caluculated from the data of the authors.

Kagoshima is south in Kyushu. Numbers following ± mean standard deviation of blood pressure. Average blood pressure of nos. 7 and 10 is caluculated from the data of the authors.

TABLE 2

Blood pressure of different provinces in Japan, Female (averages and standard deviations)

NO.	PREFECTURE, KIND OF SUBJECTS	OBSERVERS	YEARS, SEASON	NUMBER		AGE CLASS, YEARS 20–29	30–39	40–49	50–59	60–69	70–79
1.	Hokkaido, Farm villagers	Sakuma	1948 Summer	576	Systolic	117.9±11.6	121.3±12.9	124.6±16.0	137.1±14.3		
2.	Hokkaido, Farm villagers	Otokozawa	1952 Summer	324	Systolic	122.5±11.9	125.3±13.7	133.9±11.8	140.5±15.8		
3.	Hokkaido, Postal service workers	Maruyama	1953 Summer	269	Systolic	124.8±13.2	125.0±13.0	127.0±15.8	132.0±14.8		
4.	Aomori, Farm villagers	Takahashi Sasaki, Takeda and Ito	1954 Summer	376	Systolic	125.3±11.8	128.5±13.2	137.7±23.1	147.8± 9.6	163.0±30.1	168.2±28.7
					Diastolic	68.8±10.6	77.5±10.0	82.8±13.4	85.1±15.7	89.7±16.7	92.2±15.1
5.	Akita, Farm villagers	Takahashi, Sasaki, Takeda and Ito	1955 Summer	386	Systolic	136.8± 9.4	142.3±17.4	152.1±27.8	162.8±27.6	165.4±25.2	193.0±23.2
					Diastolic	79.6±10.8	81.9±17.7	85.6±14.8	87.6±12.9	88.9±15.7	97.0±14.7
6.	Akita, Farm villagers	Takahashi, Sasaki, Takeda and Ito	1955-1956 Winter	303	Systolic	138.7±17.3	150.6±31.2	151.6±27.6	169.0±34.6	178.6±29.4	212.5±33.1
					Diastolic	74.4±16.8	83.5±17.0	84.8±12.8	90.9±16.0	94.6±14.0	100.0±14.1
7.	Akita, Farm villagers	Fukuda *et al.*	1951-1953 Summer	3219	Systolic	128.8±16.6	134.2±21.0	141.3±23.5	149.1±27.4	162.2±28.3	172.1±27.7
					Diastolic	75.6±21.5	85.6±15.0	90.0±16.5	91.7±16.0	96.1±17.7	96.9±18.1
9.	Chiba, Farm villagers	Donomae and Matsumoto	1943 Summer	A 643	Systolic	126.3±14.4	134.9±18.0	142.9±22.1	145.9±23.7	151.9±30.0	172.1±30.4
				B 815	"	121.9±15.1	124.6±15.2	129.2±20.2	136.8±27.5	144.2±26.8	156.2±25.1
				C 433	"	123.3±14.3	125.2±11.5	134.0±22.9	139.9±24.6	152.1±23.6	157.5±22.2
10.	Tottori, Farm villagers	Nishimura *et al.*	1946 Summer	225	Systolic	103.6	107.0	113.3	123.5	128.1	
					Diastolic	61.0	62.0	67.2	72.4	70.2	
11.	Okayama, Farm villagers	Ōshima	1954 Summer	241	Systolic	104.2± 5.8	103.3± 6.7	110.4±10.2	121.7±10.4	139.2±15.9	
					Diastolic	61.2±13.4	64.6±11.5	72.8±12.8	72.1±11.0	77.8±14.7	

The figures clearly show that the middle-age death rate from cerebral hemorrhage is lower in the southwest, especially in the prefectures surrounding the Inland Sea, Seto, and higher in the northeast, with the exception of Hokkaidō where the rate is lower than average, than in all the rest of Japan.

Before World War II statistics of arterial pressure based on mass surveys of the population, except that of insurance policy holders were rare. During and immediately after the war, Shimizu *et al.* ('50), Watanabe ('54) and other authors pointed out a decrease of average arterial pressure (especially systolic) similar to that shown in Occidental countries. This fact must be considered in comparing the data of nos. 9 and 10 in tables 1 and 2 with the later studies summarized in the table. Series in tables 1, 2 and 3 were all measured by the auscultatory method with mercury sphygmomanometer, except nos. 8 and 10, which were measured by Tycos sphygmomanometer. Chiefly, data measured in summer are compared with each other in the tables, because of seasonal differences in average blood pressure in Japan and because differences of atmospheric temperature in different provinces are smaller in summer than in winter as shown in figure 3. Farm-villagers are the subjects of most data in tables 1 and 2; farmers and related workers are usually native, and according to the result of the census in 1950, they are the major occupational group—almost half of all working people—and are distributed evenly in all provinces except in the big cities. Living conditions of farmers are simpler than those of other citizens. Data for other occupational groups is given in some cases where that for farmers is lacking.

In tables 1 and 2 mean blood pressure is followed by standard deviation, (not standard error nor probable error). The distribution of blood pressure, especially in the older age class, is not always normal.

By comparing the data of tables 1 and 2 with that of figures 1 and 2 one can see that the distribution of average blood pressure tends to parallel that of the middle age death rate from cerebral hemorrhage. The tables, however, lack appropriate data for the south and are considerably incomplete. In tables 1 and 2 the average blood pressure of no. 11 seems too low, as if it were in the tropics. In this group a random sample among farmers, of about 50 persons for every 10 year age class, was measured in midsummer. The average blood pressure of farm-villagers in the neighboring prefecture, Tottori, is also low (no. 10 in tables 1 and 2); however, it was measured in a period of

TABLE 3

Average blood pressure in Kagoshima, Male and Female

PREFECTURE, NO.	KIND OF SUBJECTS	OBSERVERS	YEARS, SEASON	NUMBER		AGE CLASS, YEARS 20–29	30–39	40–49	50–59
12.	Kagoshima,	Sato *et al.*	1951	801	Systolic	113.0	114.4	117.0	124.0
	Sales workers,		Summer		Diastolic	59.7	67.5	68.8	78.3
	Clerks,		1952	1309	Systolic	117.8	112.8	131.5	137.1
	Students, etc.		Winter		Diastolic	71.7	70.4	92.8	105.9

food shortage, just after the war. In the distribution of the death rate from cerebral hemorrhage, Okayama Prefecture and the other prefectures surrounding the Inland Sea, Seto, show low values and the low average of blood pressure in this region may be significant.

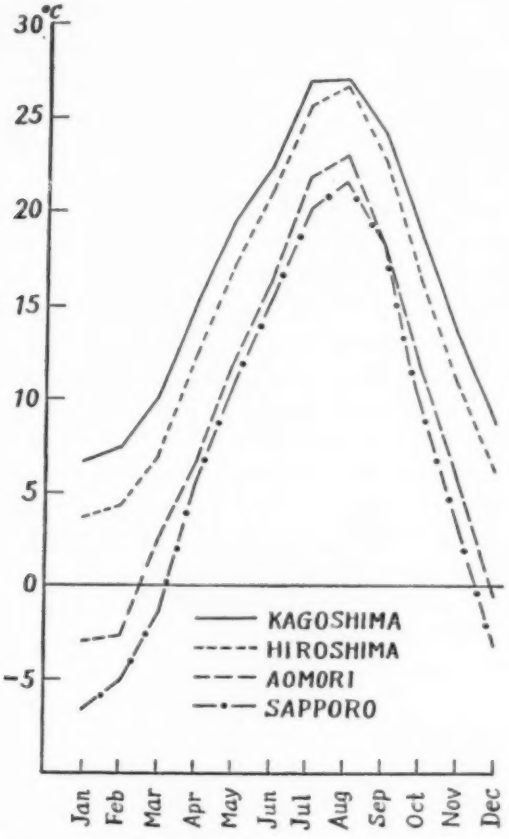

FIG. 3. MONTHLY AVERAGE TEMPERATURE IN KAGOSHIMA (IN KYŪSHŪ), HIROSHIMA, AOMORI, AND SAPPORO (IN HOKKAIDŌ).

In Japan, blood pressure readings in the brachial artery elevated to 150 mm Hg and above, systolic, and 90 mm Hg and above, diastolic, are usually regarded as hypertension, but sometimes a standard of 140 mm Hg is used as a borderline between normal and high blood pressures, especially in the south, and sometimes a standard of 160 mm Hg is used, especially in the north.

TABLE 4

Percentage and its standard error of persons whose blood pressure is 150 mm Hg and above Systolic and 90 mm Hg and above Diastolic, in various provinces

NO.	PREFECTURE, KIND OF SUBJECTS	OBSERVERS	YEARS, SEASON	SEX, NUMBER		AGE CLASS, YEARS 20–29	30–39	40–49	50–59	60–69	70–79
1.	Aomori, Farm villagers	Takahashi *et al.*	1954 Summer	M, 307	Systolic	5.6± 3.8	6.5±3.6	21.6±4.8	26.4±5.2	61.0± 6.3	65.6±10.6
					Diastolic	0	8.7±4.2	18.9±4.5	31.9±5.5	47.5± 6.4	35.6±10.7
				F, 376	Systolic	2.9± 5.9	7.0±3.4	26.0±4.5	38.7±5.1	60.6± 5.8	68.0± 9.3
					Diastolic	0	7.0±3.4	28.1±4.6	30.1±4.8	46.5± 5.9	52.0±10.0
			1955 Summer	M, 286	Systolic	0	22.7±8.9	30.7±5.2	49.5±4.9	65.7± 5.8	100.0
					Diastolic	0	18.2±8.2	20.0±4.6	44.8±4.9	47.8± 6.1	50.0±25.0
				F, 386	Systolic	9.1± 8.7	22.7±8.9	38.8±4.3	62.7±3.9	75.4± 5.2	100.0
					Diastolic	9.1± 8.7	18.2±8.2	29.5±4.0	39.3±4.0	44.9± 6.0	60.0±21.9
2.	Akita, Farm villagers	Takahashi *et al.*	1956 Winter	M, 204	Systolic	9.1± 6.1	40.7±9.4	56.3±7.1	74.6±5.6	76.2± 6.5	83.3±15.2
					Diastolic	4.5± 4.4	25.9±8.4	37.5±7.0	61.0±6.3	64.3± 7.4	66.7±19.1
				F, 303	Systolic	25.0±10.8	31.7±7.2	47.0±5.4	66.7±4.5	86.0± 4.9	100.0
					Diastolic	18.7± 9.8	21.9±6.5	30.1±5.0	45.7±4.9	60.0± 6.9	75.0±15.3
3.	Kagoshima, Sales workers, Clerks, Students, etc.	Sato *et al.*	1951 Summer	M + F, 802	Systolic	0.6± 0.4	0.5±0.5	3.2±1.4	8.9±3.8	20.0± 8.9	
			Winter	M + F, 1309	"	0.7±0.3	2.1±0.9	3.2±1.4	12.5±4.0	47.4±11.5	

Note: M: male, F: female.

Numbers following $\pm = \sqrt{\frac{p(100-p)}{N}}$, in which p = prevalence rate (percent of the hypertensions), N = number.

TABLE 5

Percentage and its standard error of persons whose Systolic blood pressure is 140 mm Hg and above in various provinces

NO.	PREFECTURE, KIND OF SUBJECTS	OBSERVERS	YEARS, SEASON	SEX, NUMBER	AGE CLASS, YEARS 20–29	30–39	40–49	50–59	60–69	70–79
4.	Hokkaido, Postal service workers	Maruyama	1953 Summer	M, 893	21.9	17.5	25.2	45.1	50.0	
				F, 269	11.1	11.8	18.9	20.0	27.3	
5.	Aomori, Farm villagers	Takahashi *et al.*	1954 Summer	M, 307	13.9± 5.8	17.4± 5.6	43.2±5.8	43.1±5.8	72.9± 5.8	85.0± 8.0
				F, 376	11.8± 5.5	21.1± 5.3	42.7±5.1	46.2±5.2	73.2± 5.3	84.0± 7.3
			1955 Summer	M, 286	23.1±11.7	40.9±10.5	45.3±5.7	71.4±4.4	77.6± 5.1	100.0
				F, 386	36.4±14.5	50.0±10.7	61.2±4.3	78.0±3.4	84.1± 4.4	100.0
6.	Akita, Farm villagers	Takahashi *et al.*	1956 Winter	M, 204	45.5±10.6	59.3± 9.5	72.9±6.4	84.7±4.7	83.3± 5.8	83.3±15.2
				F, 303	43.8±12.4	53.7± 7.8	61.4±5.3	81.9±3.8	92.0± 3.8	100.0
7.	Aomori and Akita (partly), Postal service workers	Araya	1955 Summer	M, 566	8.9± 4.2	8.2± 3.0	27.7±2.8	39.5±1.3	54.3± 8.3	
8.	Okayama, Farm villagers	Oshima	1954 Summer	M, 235	0	4.2± 2.9	2.1±1.4	21.7±6.1	21.7±6.1	
				F, 241	0	0	8.2±3.8	25.0±6.3	37.3±6.8	
9.	Ōita, Postal service workers	Okamoto	1954 Summer	M + F, 2723	4.1± 0.6	3.2± 0.7	9.6±1.2	18.3±2.4	25.9± 8.4	
10.	Kagoshima, Sales workers, Clerks, Students, etc.	Sato *et al.*	1951 Summer	M + F, 802	1.1± 0.6	1.9± 0.9	5.7±1.8	14.3±4.7	40.0±11.0	
			Winter	M + F, 1309	3.1± 0.6	4.6± 1.4	15.6±2.7	39.1±6.1	68.4±10.6	

Note: Ōita Prefecture is in northeast Kyushu.

TABLE 6

Percentage and its standard error of persons with low blood pressure (Systolic, under 100 mm Hg)

NO.	PREFECTURE, KIND OF SUBJECTS	OBSERVERS	YEARS, SEASON	SEX, NUMBER	AGE CLASS, YEARS 20–29	30–39	40–49	50–59	60–69	70–79
1.	Hokkaido, Postal service workers	Maruyama	1953 Summer	M, 893 F, 269	0.7 0	0.9 3.1	2.1 5.0	2.7 0		
2.	Aomori, Farm villagers	Takahashi *et al.*	1954 Summer	M, 307 F, 376	2.8±2.7 0	0 0	0 2.1±1.5	0 1.1±1.1	0 0	0 0
3.	Akita, Farm villagers	Takahashi *et al.*	1955 Summer	M, 286 F, 386	0 0	0 0	0 0	0 0	0 0	0 0
4.	Aomori & Akita (partly), Postal service workers	Araya	1955 Summer	M, 566	22.2±6.2	9.4±3.0	7.6±1.7	7.2±2.1	5.7±3.8	
5.	Okayama, Farm villagers	Ōshima	1954 Summer	M, 235 F, 241	34.0±6.8 35.6±7.1	41.7±7.1 39.6±7.1	18.8±5.6 34.7±6.7	23.9±6.3 14.6±5.1	6.5±3.6 7.8±3.7	
6.	Ōita, Postal service workers	Okamoto	1954 Summer	M + F, 2723	10.7±0.9	16.3±1.4	15.3±1.5	11.2±2.0	10.7±5.9	
7.	Kagoshima, Sales workers, Clerks, Students, etc.	Sato *et al.*	1951 Summer	M + F, 802	17.6±2.0	25.6±3.0	21.5±3.3	14.3±4.7	15.0±8.0	
			Winter	M + F, 1309	7.9±0.9	11.3±2.0	8.4±2.2	0	0	

Tables 4 and 5 show rate of prevalence of hypertension in the same cases as tables 1, 2 and 3. These tables show the same tendency as are indicated in tables 1 and 2; namely, the prevalence of hypertension is higher in the northern prefectures, such as Akita and Aomori, and lower in the southern prefectures, such as Okayama, Ōita, and Kagoshima. In table 6, the proportion of low blood pressure—under 100 mm Hg, systolic—is seen to be very low in the north and higher in the south.

We have also tabulated data for postal service workers in three districts: Hokkaidō (district of Sapporo), Aomori and Akita (district of the west part of Aomori Prefecture and the northern part of Akita Prefecture), and Ōita (district of Beppu). The average blood pressure of the postal service workers seems a little lower than that of farm-villagers in Hokkaidō and Aomori and Akita prefectures, especially of those over 39 years of age. There is no big difference between postal workers in Hokkaidō and those in Aomori and Akita prefectures in respect to percentage of persons whose blood pressure show 140 mm Hg and above; on the contrary Ōita clearly shows a lower percentage. Low blood pressure, under 100 mm Hg systolic, is scarcely found in farm-villagers in Aomori and Akita prefectures; in postal service workers it is found in every age class, though the percentage is small. The percentage of low blood pressure in postal service workers is higher in Ōita Prefecture than in Hokkaidō or in Aomori and Akita prefectures.

THE CAUSE OF THE PECULIAR GEOGRAPHIC DISTRIBUTION OF CEREBRAL HEMORRHAGE AND HYPERTENSION

I. *The influence of atmospheric temperature.*

The territory of Japan consists of four main islands extending from northeast (about 45° N) to southwest (about 30° N). The death rate from cerebral hemorrhage is lower in the southwest and higher in the northeast except in Hokkaidō, as shown in figures 1 and 2. The distribution of the mean blood pressure of the people and the prevalence of hypertension among inhabitants seems to be parallel to the distribution of the death rate from cerebral hemorrhage.

The geographic distribution of cerebral hemorrhage and hypertension suggest that environmental factors may be a dominant cause. It is certain, of course, that genetic factors are in part responsible for the high blood pressure that is the basis of essential hypertension. But,

genetic factors may not play so remarkable a rôle here as in the differences among different races, since the Japanese living in these provinces seems to belong to the same race, and are not notably different in body build. Even if there are some genetic differences among inhabitants of these provinces these differences should be ascribed mainly to selection and isolation for a long period of time. And then, also, environmental factors deserve consideration as a selecting factor.

It is very difficult to differentiate between the influence of genetic and environmental factors, since children usually live in their parents' houses and take the same customary diet. When children and parents have similar genetic susceptibility to hypertension and live always under similar pathogenetic circumstances tending to elevate arterial pressure, it is natural that, after a certain period, the children will get hypertension similar to that of their parents. There are provincial characteristics, not only in climate but also in the construction of houses, dietary customs, and other aspects of the manner of living. If there prove to be differences between provinces in cerebral hemorrhage or hypertension, these should not be interpreted simply as the result of the genetic factor. First we must investigate the environment.

Among environmental factors, climate seems to be first in applicability to the interpretation of the higher death rate from cerebral hemorrhage and the higher prevalence of hypertension in the northeast of Japan, except in Hokkaidō. In support of this argument note that the death rate from cerebral hemorrhage has a seasonal variation, as shown in figure 4. A significant difference between average blood pressure measured in summer and in winter was recognized in the same occupational group in Kagoshima, by Satō *et al.* ('52) as shown in tables 3, 4 and 5. Such a difference was also recognized by examining the same group of 199 individuals in Aomori Prefecture in both summer and winter (Takahashi *et al.*, '55). Mishima *et al.* ('53) found a tendency, in 4,214 male insurance applicants in Ōsaka and Kyōto, for the average blood pressure of people over 40 years of age measured in autumn and winter to be higher than that measured in spring and in summer. Monthly measurement of blood pressure in 16 young males by Ohashi ('48) in Yokosuka gave significant negative correlations between atmospheric temperature and blood pressure (systolic $r = -0.94$; diastolic $r = -0.92$, $P < 0.001$). Cold is the most general kind of stressor for people who live in the temperate zone; and the idea that repeated exposure to this environmental influence, which normally raises

arterial pressure, eventually leads to a sustained hypertension is argued by Smirk ('49) and by Wolff and his colleagues ('51).

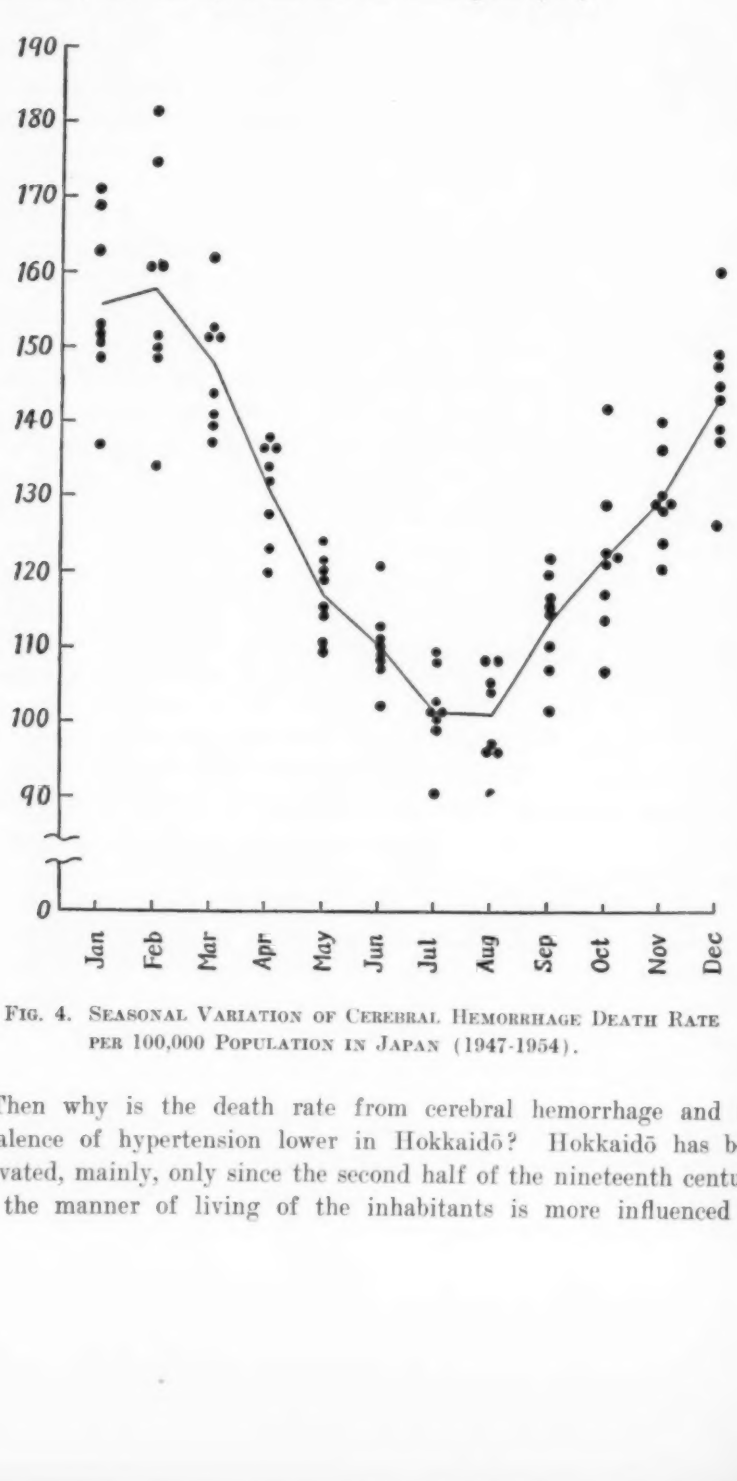

FIG. 4. SEASONAL VARIATION OF CEREBRAL HEMORRHAGE DEATH RATE PER 100,000 POPULATION IN JAPAN (1947-1954).

Then why is the death rate from cerebral hemorrhage and the prevalence of hypertension lower in Hokkaidō? Hokkaidō has been cultivated, mainly, only since the second half of the nineteenth century, and the manner of living of the inhabitants is more influenced by

Occidental ways than is that of those living in the other provinces of Japan. In winter, heating with iron stoves, without which man can scarcely live through the colder season, prevails throughout this island. On the other hand, in the main island, even in the northeast, heating with iron stoves does not always prevail as in Hokkaidō, and the construction of houses is rather protective against the heat of summer as is usual in most of Japan. Therefore, people in Hokkaidō pass the winter in a warmer in-door environment than do those on the main island; in winter travellers from Hokkaidō to the main island are sometimes more sensitive to cold in the room than are the people who live there.

In Aomori Prefecture, which is at the north end of the main island, and in neighboring Hokkaidō, heating with iron stoves in which firewood is used began earlier and spread more widely than in the other prefectures in the northeast. The death rate from cerebral hemorrhage and the prevalence of hypertension in Aomori Prefecture is lower than in the neighboring prefectures. In Aomori Prefecture, also, in villages where the heating is more general and earlier, the average blood pressure is lower than in the other villages.

Atmospheric warmth in winter has been recorded by the self-registering thermometer in the sitting rooms of farm-houses with iron stoves and those with only a floor hearth without chimney (figure 5). Firewood is the common fuel for both stove and floor hearth. But the farm-house without stove and with only a floor hearth, which is general in the older style farm-houses in Japan, except in Hokkaidō, usually has no ceiling in the sitting room so as to avoid much of the toxicity of carbon monoxide and smoke even though there is no chimney. Therefore, only radiation is effective in warming the body of the dweller, and the atmospheric temperature in the room is more influenced by the out-door temperature. The temperature of the room almost always remains under 10° C in winter and often drops below 0° C, even in the daytime, as shown in figure 5. On the other hand, in a room with an iron stove the in-door temperature is almost always kept above 20° C except at night.

Subjects aged 40–69 in farm-villages in Aomori and Akita prefectures whose blood pressures were measured by Riva-Rocci's mercury sphygmomanometer in summer, were divided into two groups: one group (A) had iron stoves in their sitting rooms and the other (B) had floor hearths only. The difference in average systolic blood pressure

between these two groups is significant at the level of $P < 0.001$ by χ^2 test, as shown in table 7. The relation of temperature in the room

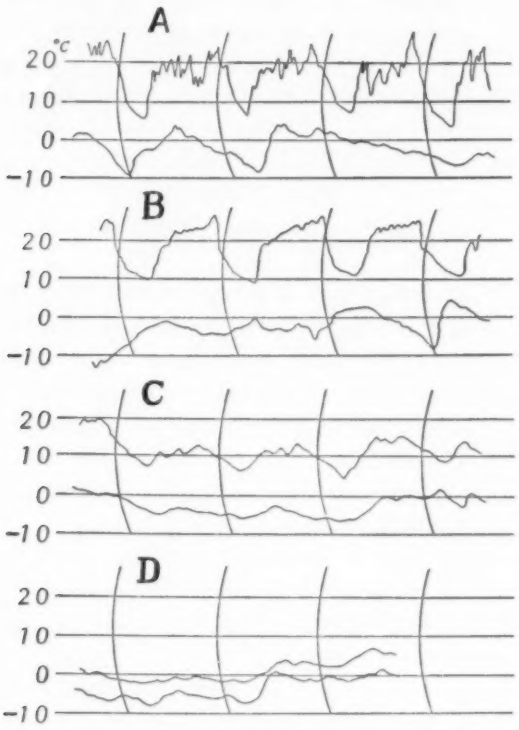

FIG. 5. THERMOGRAM OF ATMOSPHERIC TEMPERATURE IN THE SITTING ROOM WITH AND WITHOUT HEATING.

A: With stove of iron, in wooden-house.
B: With stove of iron, in concrete-block-house.
C: With *pechka*, in wooden-house.
D: With floor-hearth only, in wooden house.

The upper line shows the atmospheric temperature in the room, the lower line shows the out-door atmospheric temperature at the same time. A and D are the most usual winter patterns in the northeast farm-villages.

and blood pressure is higher in females than in males. This may be understood from the fact that women usually stay in the home, while men work hard outdoors (which brings bodily warmth) or are likely to be in well-heated offices or public structures.

Lower blood pressure occurs especially in farmers who have had heating by stove in their sitting-room for over 5 years. Possession of heating in rooms seems related to the economic condition of farmers.

TABLE 7

Difference in the incidence of hypertension of farmers with and without stoves in their houses in Aomori and Akita Prefectures

MALE

Group	Number of Hypertensives	Normotensives	Total
With stove	93	148	241
Without stove	59	63	122
Total	152	211	363

$\chi^2 = 3.174, \quad 0.05 < P < 0.10$

FEMALE

Group	Number of Hypertensives	Normotensives	Total
With stove	140	190	330
Without stove	98	74	172
Total	238	264	502

$\chi^2 = 9.599, \quad P < 0.01$

Male plus female $\chi^2 = 12.542, \quad P < 0.001$

Notes: 1. Subjects are farm villagers and aged 40–69 of both sexes.

2. Hypertensives mean subjects whose systolic blood pressure showed 150 mm Hg and above.

However, when the total farm area is considered, the influence of this economic factor upon blood pressure is negligible as shown in the data in table 9.

Again, among 290 farm-villagers whose blood pressure was measured once in summer and once in winter, the elevation of average systolic blood pressure in winter is recognized to be at the level of significance of $P < 0.01$ in a group which contains 42 villagers who have only a floor hearth and 84 who have had stoves 5 years or less, as shown in table 8. On the contrary, as shown by another group which contains 164 villagers who have had stoves 6 years and longer, a significant

elevation of average blood pressure in winter is not recognized ($P > 0.05$). Between these two groups, the difference in the winter to summer proportion of persons whose blood pressure is elevated 10 mm Hg or over is significant at the level of $P < 0.01$ by the χ^2 test.

TABLE 8

Average elevation of systolic blood pressure in winter compared with that in summer in the same 290 persons, grouped by possession of heating in house

GROUP	PERSONS	AVERAGE ELEVATION OF E. P. IN MM HG	STANDARD DEVIATION
With stove 6 years and longer	164	+1.4±1.5	19.0
With stove 5 years and less	84	+11.0±2.0	18.5
Without stove	42	+11.1±3.3	21.7

Note: Numbers following ± mean standard error of average elevation of B. P.

Significance of difference of blood pressure elevation between two groups

GROUP	PERSONS WHOSE B. P. ELEVATED	NOT ELEVATED	TOTAL
With stove 6 years and longer	71	93	164
With stove 5 years and less / Without stove	78	48	126
Total	149	141	290

$\chi^2 = 9.878, \quad P < 0.01$

Note: Persons whose systolic blood pressure was 10 mm Hg or more higher in winter than in summer are listed as "elevated."

The influence upon blood pressure of microclimate in the sitting room should be considered in two ways, direct and indirect. Directly, low temperature contracts the surface arteries; indirectly, temperature influences the amount of rice and sodium chloride eaten.

The fact that cerebral hemorrhage and hypertension in Japan are high in the northeast and low in the southwest, seems to be roughly related to the in-door temperature in the sitting room.

TABLE 9

Relation of the farm area and the prevalence of hypertension (over 150 mm Hg, systolic) in farmers in the northeast farm-villages

FARM AREA FOR VEGETABLES	NUMBER OF HYPERTENSIVES	NORMOTENSIVES	TOTAL
Under 20 are	122	78	200
20–40	64	64	128
40 are and over	62	88	150
Total	248	230	478

$\chi^2 = 13.46, \quad P < 0.005$

FARM AREA OF RICE FIELD	NUMBER OF HYPERTENSIVES	NORMOTENSIVES	TOTAL
Under 0.5 ha	51	56	107
0.5–1.0	71	73	144
1.0–1.5	65	72	137
1.5 ha and over	39	42	81
Total	226	243	469

$\chi^2 = 0.29, \quad P > 0.90$

FARM AREA, TOTAL	NUMBER OF HYPERTENSIVES	NORMOTENSIVES	TOTAL
Under 1.0 ha	77	51	128
1.0–1.5	73	63	136
1.5 ha and over	89	100	189
Total	239	214	453

$\chi^2 = 5.14, \quad 0.10 > P > 0.05$

Note: Agriculture in Japan is intensive, and the farm area is generally smaller than that in the U. S. A.

II. *On the influence of dietary customs.*

Besides the influence of atmospheric temperature, food and dietary customs seem to influence blood pressure and the death rate from cerebral hemorrhage. Keys, Henshel and Taylor ('47) found that during semi-starvation blood pressure diminishes following a drop in

the body weight. Similar changes were observed during starvation in the last great war in Europe. Namely, Lups and Francke ('47) recognized in 1945 in 520 patients in Holland that blood pressure had fallen substantially. According to Brožek, Chapman and Keys ('48) after the siege was lifted in Leningrad it was found that arterial pressure increased. Also in Japan, in the period of food shortage, during and

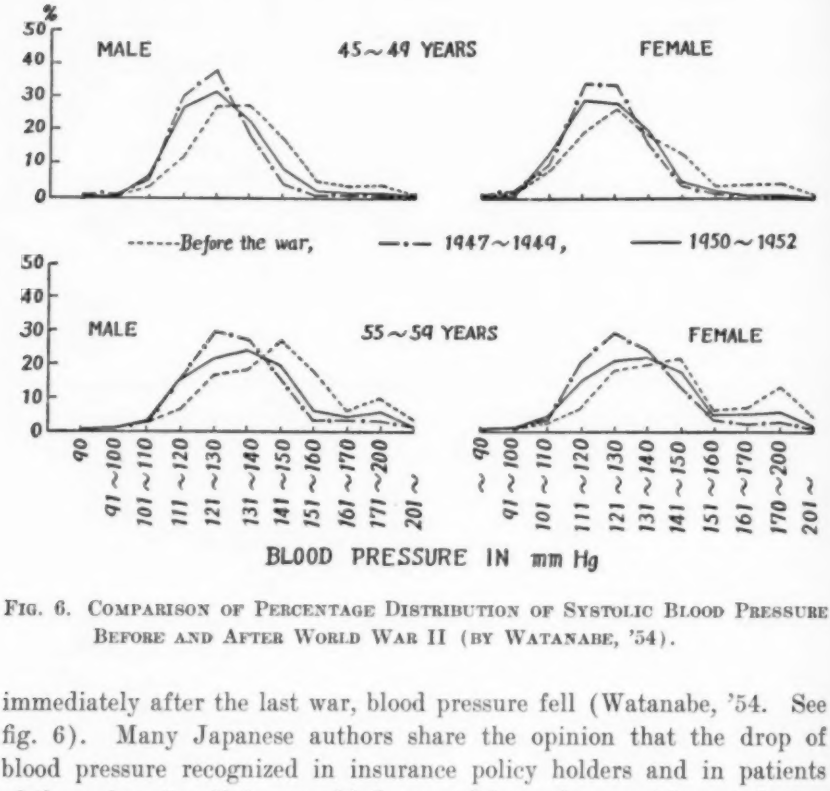

FIG. 6. COMPARISON OF PERCENTAGE DISTRIBUTION OF SYSTOLIC BLOOD PRESSURE BEFORE AND AFTER WORLD WAR II (BY WATANABE, '54).

immediately after the last war, blood pressure fell (Watanabe, '54. See fig. 6). Many Japanese authors share the opinion that the drop of blood pressure recognized in insurance policy holders and in patients of the university clinic was chiefly caused by under-nourishment during and just after the war. According to government vital statistics, the crude death rate from cerebral hemorrhage, which was about 180 per 100,000 population in 1938-40, dropped one-third to about 120 in 1948-49.

On the influence of dietary customs, Professor Kondō ('55) of Tōhoku University, who has studied dietary customs and longevity in Japan for more than 15 years, states that: (1) the longevity index—

per cent of persons over 70 years in populations which are not rapidly increasing or decreasing—is always low in villages where inhabitants have a partiality for rice and eat over 700 g (*ca.* 2400 Cal.) of rice daily; (2) inhabitants of villages where the longevity index is high always eat enough fish, or much food processed from soy beans and many vegetables; (3) in villages where inhabitants usually eat sea weed, there are very few incidents of cerebral apoplexy and the longevity index is high, etc. Whether the longevity index of a village is high or low is influenced mainly by the incidence of cerebral hemorrhage in the middle age class. Significant negative correlation (male, $r = -0.81$, $P < 0.001$; female, $r = -0.77$, $P < 0.001$) is found between longevity index and middle age death rate from cerebral hemorrhage in 38 prefectures, not in 8 prefectures containing big cities or industrial districts which have a different age-sex distribution of population from others (Takeda, '56).

In Occidental countries, high protein diet seems generally to be one of the causes of hypertension, though Dublin, Fisk and Kope ('25) found no significant difference in the percentage of hypertension in those taking a high protein diet and those who did not. Recently, in Occidental countries, a rice diet is sometimes used for the treatment of hypertension. The quantity is always limited to about 2,000 Calories, however, and is accompanied with a severe restriction of sodium chloride.

In Japan, especially in farm-villages in the single crop area, where farmers have comparatively large rice fields (*ca.* 1-2 hectare) but smaller fields for vegetables (*ca.* 2-3 are), which are usually for home consumption only, farmers tend to overeat rice, with only small side dishes, generally of thick salted pickles. According to the results of the government national nourishment survey, adult farm-villagers of all provinces take an average of *ca.* 2,500 Cal. of which 55-65% is in rice. Takahashi *et al.* ('54) found that in the customary diet in farm-villages in a single rice crop area of Aomori Prefecture, where the country is covered with drifted snow during three or four months in winter, 70-80% of the calories of all foods (*ca.* 3000 cal.) are from polished rice and that in the period from March through May, it often exceeded 80%. Polished rice is lacking in vitamins. Therefore, the larger the amount of rice they eat, the more they lack in vitamins, and latent polyavitaminosis is found very often in the farm villages. We found the customary diet lacking adequate vitamin B_1, B_2, C, etc. and also calcium and fat. Farmers who have fields too small for

vegetables lack vegetables, especially during winter and spring, since they do not buy them, and eat much rice with thick salted pickles.

In the northeast, the larger the vegetable fields—vegetables are mostly for home consumption—the less the prevalence rate of hypertension (Itō, '56). As shown in table 9, when 478 farmers are divided into three groups according to the extent of farm area used for vegetables, the differences of prevalence rate among these three groups are statistically significant by the χ^2 test at the level of $P < 0.005$. On the other hand, there is no significant relation between the area of rice fields and the proportion of hypertensives. Although agricultural labor is heavier in the rice fields than in the fields for vegetables, it seems probable that physical exertion is not an important factor in the genesis of essential hypertension (Pickering, '55).

We find there is a significant positive correlation between estimated production of rice (average for 1942-50) per capita (both estimated production and population are cited from the government Statistical Yearbook, 1950) and the middle age death rate from cerebral hemorrhage (male, $r = +0.602$, $P < 0.001$; female, $r = +0.552$, $P < 0.001$) in 42 prefectures (except Tōkyō, Kanagawa, Ōsaka and Kyōto prefectures, which have small farm areas as against large urban populations). It follows, under the premise that inhabitants in prefectures where more rice is produced eat more of it, that, in Japan, the people who eat more rice have a higher incidence of cerebral hemorrhage. The low death rate from cerebral hemorrhage in Hokkaidō is explained by the low productivity of rice resulting from the climate, in addition to the above-mentioned influence of higher indoor temperatures in winter.

Ogata *et al.* ('54) state after their experiments on the influence of a large amount of sodium chloride ingestion in North Manchuria as follows: "Daily intake of sodium chloride amounting to 50–60 g by adding 10 g to each meal causes a gradual rise in basal metabolism, good appetite, and energetic feeling of the body, after several days. In this stage of high metabolic rate due to increase of salt ingestion, both a rise in the oxygen consumption and a drop in the surface temperature during exposure to cold are less in degree and the subjects complain less than normal subjects." Though the observation was not continued for so long a period, it seems that it would be good to take more sodium chloride in colder environments. However, at the same time, it is well known that overdosages of sodium chloride in daily life

produce hypertension: *e.g.*, Dahl and Love ('54) state that no hypertension was found among a low sodium chloride intake group, but a high intake group had hypertension in 10% of the subjects. Sasaki ('56a) has shown that the soy bean paste, "miso," from which the soup is made which almost all Japanese eat every day (farmers eat it always, at each meal) contains more sodium chloride in the north than in the south of Japan and that there is significant positive correlation ($r = +0.49$, $P < 0.01$) between the sodium chloride content of the paste and the middle age death rate from cerebral hemorrhage in 36 prefectures.

Sasaki ('56b) investigated the quantities of sodium and potassium (by flame photometer), chlorine and creatinine in the urine of 97 farm housewives, aged 31–64 years, in farm villages: village A in Aomori prefecture and B in Akita prefecture. Village A is in the area of apple production and all subjects (41) have iron stoves for heating in their sitting room: 32 of them have had stoves for over 10 years. Of the subjects of village B (56), only 7 have had iron stoves for over 10 years, and 24 still lack stoves. There proved to be no difference in upper-arm circumference between these two groups of farm-housewives, and, as this is the simplest and most definite way to compare physical build of different groups as it relates to blood pressure (Bays and Scrimshaw, '53), body build does not appear to be a factor, here. But there is a significant difference of average blood pressure, both in systolic (in village A: 132.1±2.6, in B: 171.8±4.8 in mm Hg; the number following ± being the standard error) and in diastolic (in A: 78.4±1.8, in B: 90.4±2.2 in mm Hg), and of percentage of hypertension, between these two groups. In the urine, there were remarkable differences in the ratio of Na/creatinine and of Na/K between group A:

[Na(m. Eq.)/Cr.(g) : 242.1±18.9; Na(m. Eq.)/K(m. Eq.) : 4.72±0.38]

and group B:

[Na(m. Eq.)/Cr.(g) : 383.0±23.1; Na(m. Eq.)/K(m. Eq.) : 7.14±0.60].

It seems that one should take more sodium chloride in a cold environment, such as in the rooms which have no heating during winter except the floor-hearth.

Irie ('53) found a decrease in vitamin C concentration in blood serum after 4–5 days of adding 20 g NaCl to the ordinary diet; this is in accordance with the results of animal experiments by Doi ('53).

In farm-villages in the northeast of Japan, it seems farmers lack vitamin C doubly, not only in their food but also by excessive intake of sodium chloride. In fact, Matsuoka *et al.* ('51), Fukuda *et al.* ('52), Okumura ('55), and Sasaki, Takeda and Itō ('55) have found low blood levels of vitamin C especially in the season of snow-drifts in this province.

Anyhow, excess intake of rice and salt and lack of vitamin C and other vitamins seems to be one of the important causes why, in the northeast, the average blood pressure is elevated and the death rate from cerebral hemorrhage is high. Excess intake of rice, especially, seems to influence the geographic distribution of cerebral hemorrhage in Japan.

III. *On the influence of psychogenic factors and of social environment.*

On the influences of psychogenic factors and of social environment upon cerebral hemorrhage and hypertension we have no appreciable data in Japan. It is said that the inhabitants of coast villages, especially fishing villages, tend to be extroverts in personality in comparison with the inhabitants of inland villages where they seem to be introverts. The inhabitants of such fishing villages usually seems to have lower mean blood pressure, lower prevalence of hypertension and a lower death rate from cerebral hemorrhage than those of inland and mountain farm-villages. But we have no certain evidence on the relation of personality and blood pressure.

In table 10, which shows death rates from chief causes by occupation, we find higher death rates from cerebral hemorrhage in occupation classes of other professional workers and farmers, farm workers, and graziers, in which cerebral hemorrhage is the most important cause of deaths, though the death rates are not corrected for age and sex. As for farmers and related workers, who are the greater part of the population of Japan, we can interpret the geographic distribution of cerebral hemorrhage and hypertension by atmospheric temperature and dietary customs, as mentioned above. Other professional workers seem to contain more urban inhabitants. The fact is generally recognized that "the blood pressure cuff reveals higher values in complex societies than in simpler social environments," as Bays and Scrimshaw ('53) put it. That other professional workers have the highest death rate from cerebral hemorrhage seems mostly explained by that idea, even though they seem to contain the older generation.

TABLE 10

Death rates from chief causes by occupation in Japan, 1951-1952
(from Mortality Statistics by Occupation and Industry, 1955)

OCCUPATION	CHIEF CAUSES	TUBERCULOSIS	MALIGNANT NEOPLASMS	CEREBRAL HEMORRHAGE	HEART DISEASES	ACCIDENTS
Professional and technical workers	Technical workers	*135.6*	63.8	54.7	36.6	63.8
	Professors and teachers	*112.5*	39.8	35.9	22.6	16.0
	Other professional workers	167.5	147.6	*187.6*	101.2	36.2
Managers and officials		91.4	*105.7*	104.1	54.5	31.3
Clerical and related workers		*150.7*	54.6	43.9	34.6	30.5
Sales workers		*120.8*	105.0	116.3	71.3	39.0
Farmers, farm workers, and graziers		77.1	114.0	*153.3*	25.9	38.0
Lumbermen, hunters, and related workers		43.7	29.4	43.4	25.5	*156.3*
Fishermen and related workers		87.3	83.8	69.9	49.2	*103.4*
Workers in mines and quarries		130.0	60.0	47.3	35.7	*315.1*
Workers in transportation		101.4	39.1	30.3	25.1	*149.4*
Workers in metals		*131.2*	51.1	38.4	35.2	59.4
Workers in textiles		*105.7*	71.9	61.9	52.8	35.7
Workers in fabricated textiles		*177.2*	45.6	60.8	49.4	21.5
Workers in wood and wood products		97.7	74.3	74.8	47.1	49.0
Machinery operators and related workers		68.1	34.1	33.0	23.1	83.5
Other craftsmen		*102.8*	56.0	57.8	40.4	66.8
Laborers (except farm, mine, and services)		93.5	56.8	61.4	45.9	*122.0*
Protective service workers		*149.1*	44.2	34.5	26.4	40.3

Note: Italic death rate numbers mean the most significant causes of deaths for each occupation.

However, higher death rate from cerebral hemorrhage and higher mean blood pressure in the northeast of Japan compared with the southwest is not explained by social environment, since in Japan it is common knowledge that inhabitants in the northeast are regarded as having a less complex society and a less elaborate culture than in the southwest.

SUMMARY

In Japan the incidence of fatal cerebral hemorrhage among the middle aged is higher in the northeast, except in Hokkaidō, than in the southwest. The distribution of the mean blood pressure, the prevalence of hypertension and the proportion of low blood pressure seem parallel to the distribution of the death rate from cerebral hemorrhage, though we are lacking in data from local mass surveys for some parts of Japan.

This geographic distribution of cerebral hemorrhage and hypertension seems explained in part by the differences of atmospheric temperature. One must consider not only natural, out-door temperature but also in-door temperature which, especially in winter in the north of Japan, is more effectively influential upon the human body. Areas where cerebral hemorrhage and hypertension are frequent in farm villages also seem to be those in which there is a surplus intake of rice and salt, and a lack of vegetables.

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THE RELATIONSHIP BETWEEN PHYSIQUE AND RATE OF SKELETAL MATURATION IN BOYS

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IN a recent analysis of the Brush Foundation Growth Study material, Dupertuis and Michael ('53) compared the growth pattern of two groups of boys with different physiques. It was found that those who were predominantly of a rugged, muscular build (Sheldon's second component) grew more rapidly than those whose physique was more finely and delicately constructed (Sheldon's third component), but that the latter group were, on average, taller as adults. This finding is consistent with Shuttleworth's ('37, '38) observation that slow physical maturation during adolescence is associated with greater than average adult height, and rapid maturation during the same period with shortness of stature. Acheson and Hewitt ('54) found that, in the pre-school period, the group of children of either sex which reached a given stage in their skeletal maturation late were taller at that stage than the group of children who reached the same stage early; this suggested that the inverse relationship between adult stature and rate of physical maturation might be a basic, constitutional pattern which is genetically determined and is detectable from early childhood. What is more, it seemed highly probable that there would be a basic relationship between Sheldon's somatotypes and the rate of physical maturation—either skeletal or sexual. The present paper investigates the validity of this hypothesis in respect of the same group of boys as were used in the earlier paper (Dupertuis and Michael, '53).

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MATERIAL AND METHODS

Material

Full details of recruitment and conduct of the Brush Foundation Study have been published elsewhere (Simmons, '44). The children who provided the longitudinal data were all born after the first World War, and the majority of them were followed between 1931 and 1942. They were specially selected from prosperous homes with the idea that this would permit the study of child development under optimum conditions. At the time that recruiting was going on it was widely believed that obesity in childhood was an indication of pituitary insufficiency, and therefore, although children who tended to be fat were followed, their records were not filed among the normal or "regular" series. In 1951, when a circular letter was sent to the 250 boys whose records were the most complete, asking them to return for a final assay of adult physique, this fact was not realized. Consequently, among the 128 who eventually presented themselves at this laboratory there is an artificially small amount of Sheldon's first component (roundness and fatness).

Somatotyping

The 128 boys whose physiques were classified had all reached young adulthood. The classification was made by the classical method of Sheldon (Sheldon, Stevens, and Tucker, '40; Sheldon, Dupertuis, and MacDermott, '54) from standard photographs of the naked individual.

Assessment of Skeletal Maturation

Skeletal maturity was assessed from x-rays of the hip and pelvis by the Oxford method[2] (Acheson, '54, '56, '57). This part of the body was chosen for no other reason than that its maturation had already been assessed in a separate study (Acheson, '57), and that maturity

[2] This method depends upon the recognition of shape changes in the parts of the maturing skeleton where osteogenesis is occurring. Those shape changes which are neither sex-limited nor stock-limited are described as maturity indicators, and the total number of these indicators in any x-ray film is known as the maturity score, which is taken as an index of the maturity of the whole skeleton. In the first report of this method (Acheson, '54) the scores were described as Oxford Units. It has since been realized that the various contributions to the total maturity score are not necessarily equal to each other, and so it is incorrect to describe them as units. In the present communication they will be referred to as maturity points.

readings were thus available for a total of 225 Brush boys, including the 128 who had been somatotyped. The mean maturity scores, together with standard deviation for this entire group, are shown in table 1.

TABLE 1

Mean maturity score in points for the hip and pelvis of 225 Brush Foundation Study boys, assessed by the Oxford Method from 2,505 radiographs (The maximum score, attained by the mature individual, is 45 points.)

AGE IN YEARS	MATURITY SCORE IN POINTS MEAN	STANDARD DEVIATON	NUMBER OF OBSERVATIONS
¼	4.45	1.01	53
½	6.31	1.06	61
¾	7.71	0.87	70
1	8.37	0.82	78
1½	9.34	0.85	88
2	10.11	0.89	96
2½	11.14	1.10	104
3	12.05	1.26	108
3½	12.94	1.30	111
4	13.98	1.33	126
4½	14.98	1.47	128
5	15.97	1.42	139
6	17.25	1.43	150
7	18.39	1.40	149
8	19.57	1.35	149
9	20.71	1.32	138
10	21.90	1.52	145
11	23.35	1.73	116
12	24.98	2.06	114
13	26.85	2.38	102
14	29.72	2.61	86
15	32.56	3.28	72
16	36.13	3.96	60
17	39.54	3.17	41
18	40.95	3.15	21
Total			2,505

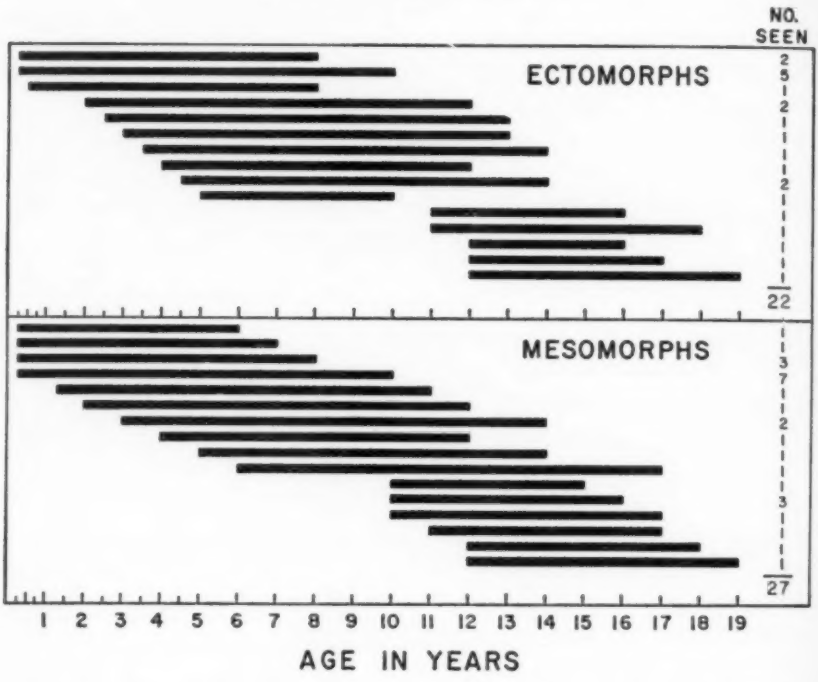
None of the boys who were somatotyped had been studied for more than 11 years, and very few of them for less than 5. The actual ages at which some of them were seen are indicated in table 2. The maximum number of x-rays available for any child was 18.

The following procedure was adopted in order to obtain an index scale of the rate of maturation for each child. From the maturity

score of each x-ray, the mean maturity score of those members of the entire group of 225 boys who were seen at the same age was subtracted. Then this difference, in maturity points, was divided by the standard deviation of the scores of all the boys at that age and multiplied by 100.

TABLE 2

A diagrammatic presentation of the time span during which the 22 ectomorphs and 27 mesomorphs were followed. With very few exceptions each child was seen every three months in the first year of life, twice yearly until he was 5, and then annually. These cases are typical, in this respect, of the Brush Foundation data.


NO. SEEN
ECTOMORPHS
2 5 1 2 1 1 1 2 1 1 1

simple index was preferable to the more elaborate method of trying to fit curves to the maturational pattern of each child.

FINDINGS

Overall Relationship between Physique and Rate of Skeletal Maturation

The fact that there is a wide normal range in the rate of skeletal maturation in boys of the Brush group has been demonstrated by Pyle and Hoerr ('55). In order to obtain a broad picture of any differences in physique that there may be between the slow maturing and quick maturing boys, the present study group was divided, in terms of the rate of maturation index, into four subgroups (see table 3). It will

TABLE 3

Average somatotype components in four groups of Brush boys, arranged according to rate of skeletal maturation

	RATE OF MATURATION SCALE (IN STANDARD UNITS)			
	SLOW		FAST	
	—100 or less	—99 to 0	0.1 to 100	101 or greater
Component I (Endomorphy)	3.30	3.36	3.40	3.60
Component II (Mesomorphy)	4.07	4.11	4.15	4.45
Component III (Ectomorphy)	3.87	3.46	3.16	3.05
Number of Observations	(15)	(60)	(43)	(10)

be seen that somatotype Component II (ruggedness) is higher among the fast maturers, and Component III (delicacy and linearity) is higher among the slow maturers. There is also the suggestion of a gradient for Component I, with even less roundness and softness among the slow maturing group than among the boys who are skeletally more precocious. The findings are strikingly similar to those of Tanner ('55), who compared somatotype components with rate of sexual maturation, judged by first appearance of pubic hair, in a group of 188 British officer cadets. Tanner found, however, that the relationships between somatotype Component II and fast maturation and between Component III

and slow maturation were both statistically significant. In the present data only the linear regression of Component III and rate of skeletal maturation differed significantly from zero ($.01 < P < .05$). Tanner's subjects, in whom Component I averages lower than in ours, showed no consistent trend in respect of this component.

In addition to considering the physique of the boys in relationship to their rate of maturation, partial linear regressions were calculated for the rates of maturation associated with the three somatotype components. For all three combined, no significant relationship was detected; however on further analysis ectomorphy was found to have a relationship with slow maturation ($.01 < P < .05$).

Rate of Skeletal Maturation

1. Preponderance of Components II and III. In order to examine the developmental patterns of boys showing a high degree of Components II and III, the same group of 22 boys with more than 5.0 in Component III were studied as had been used in the previous analysis (Dupertuis and Michael, '53). Two of the 27 mesomorphs were not 18 years of age and therefore not quite fully grown when last seen, so that only 25 boys with more than 5 in Component II were available. A scattergram was made (figure 1) in which rate of maturation was plotted against final adult height for the two groups. This shows a highly significant tendency for boys with a delicate and linear physique (Component III) to be slower maturing and taller ($\chi^2_{(2)} = 11.68$, $.001 < P < .01$) than boys with a predominance of Component II.

2. Gynandromorphy. Gynandromorphy was estimated in all the boys by the method of Sheldon ('40), but it was found that only 9 had a rating of over 3.0 in this component. Thus we are unable to affirm or to refute Bayley's ('51) statement that boys who are gynic in their physical build mature more quickly than average.

The Relationship between Physique and Pattern of Skeletal Maturation

It is half a century since Pryor ('08) pointed out that the pattern of ossification in children varies considerably. He believed that this variation was entirely due to genetic differences. Subsequently, Pryor himself ('39), Buschke ('34), Sontag and Lipford ('43), and other authors have produced good evidence in favor of the suggestion that variations in pattern have a genetic basis. Todd ('37), however, con-

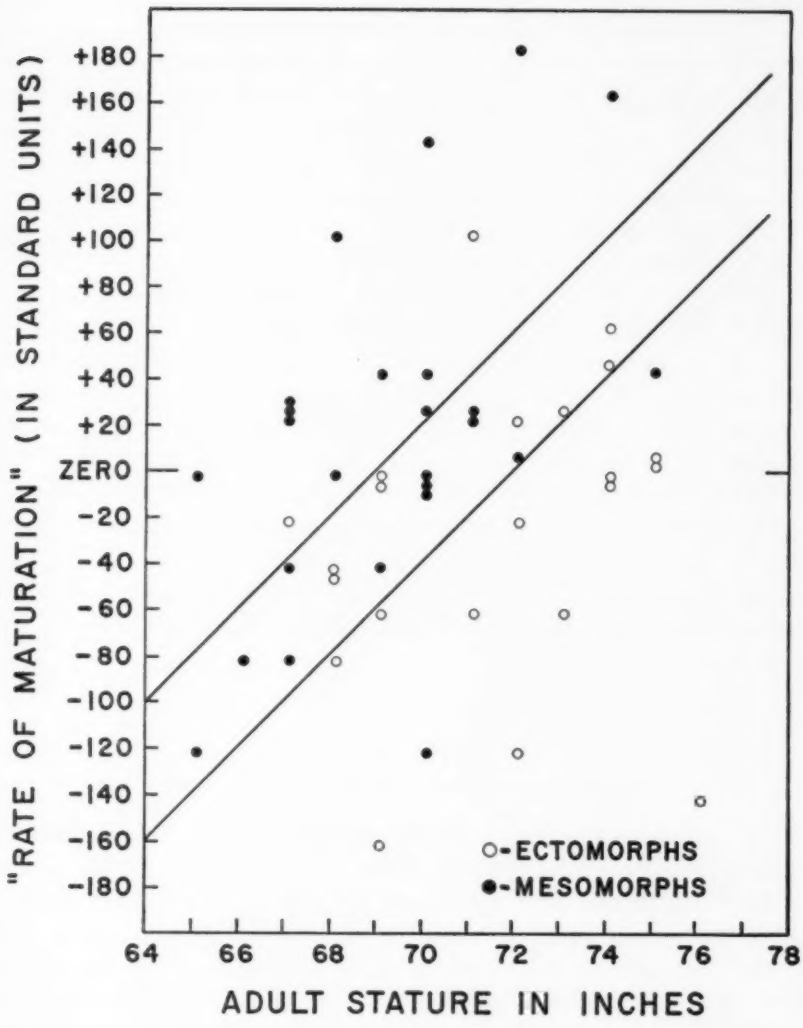


FIG. 1. A SCATTERGRAM SHOWING THE ADULT STATURE AGAINST RATE OF SKELETAL MATURATION OF 22 BOYS WITH A RATING OF 5 OR ABOVE IN COMPONENT III AND 25 BOYS WITH 5 OR ABOVE IN COMPONENT II.

tended that illness or malnutrition could also disturb the pattern of ossification. The use of the Red Graph by Pyle and her co-workers ('48) in a group of children in Michigan and also in Birmingham, Alabama (reported by Driezen, Snodgrasse, Parker, Currie, and Spies, '54), has borne out Todd's contention. Subsequently, further support came from Hewitt, Westropp, and Acheson ('55), who showed that the maturation of the carpals was more susceptible to interference from the intercurrent illnesses of childhood than the maturation of the epiphyses of the short or the long bones in the wrist or the knee. Thus, it seemed that both heredity and environment each play their part in determining the pattern of skeletal maturation in children.

We have already shown that there is some relationship between physique and rate of maturation, and the question arises as to whether the pattern of skeletal maturation might also have some association with physique. That is to ask, whether the slower rate of maturation associated with ectomorphy reflects a general and equal slowing of the development of all ossific centers, or whether a differential effect can be detected between one type of center and another? In order to study this question further, a detailed comparison was made between three different types of center in the predominant mesomorphs and the predominant ectomorphs. The remaining 79 boys who were not predominant in either component served as controls. The centers chosen for study were:

1. Articular epiphysis—Head of femur
2. Traction epiphysis—Greater trochanter
3. Primary center—Junction of pubic and ischial rami.

Each of these provided a single maturity indicator series, and the stages observed are illustrated in figure 2.

The comparisons were made both by estimating the mean ages at which the various maturity stages were achieved by each group, and by plotting graphically the ages at which each of the boys showed the indicators in each of the three series. The numbers at each age were too few to apply tests of statistical significance; nevertheless the following trends appeared to be fairly consistent.

Articular epiphysis (head of femur). There was no suggestion of a difference in the mean age of first appearance of the center of ossification of the head of femur (Stage 1) among the three groups, nor was

there any difference in the ranges of these means. Thereafter, through Stage 6, each of the three groups remained strikingly similar. However, whereas the mesomorphs on an average took only 36 months to pass from Stage 6 to Stage 7, the control group took 43 months and the ectomorphs 53 months. There was little suggestion of a difference in the times for each of the three groups to pass from Stage 7 to Stage 8.

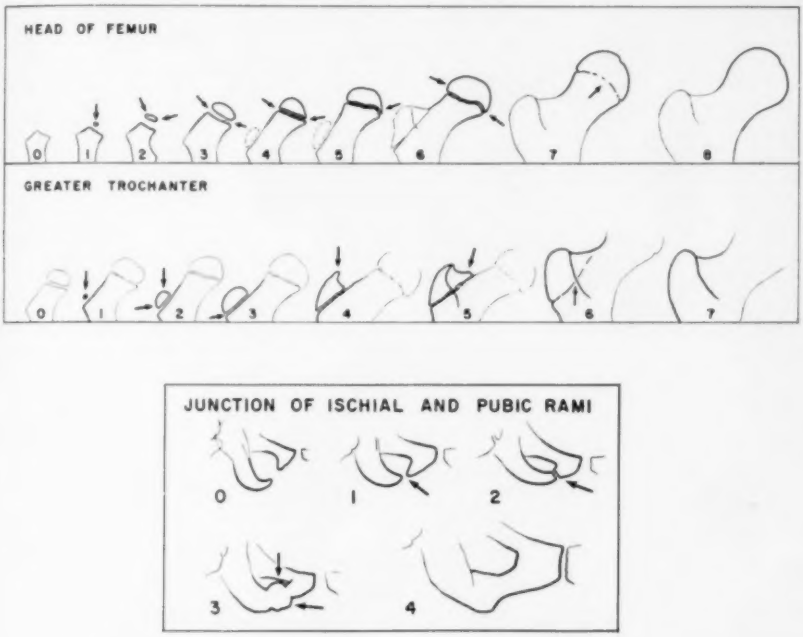


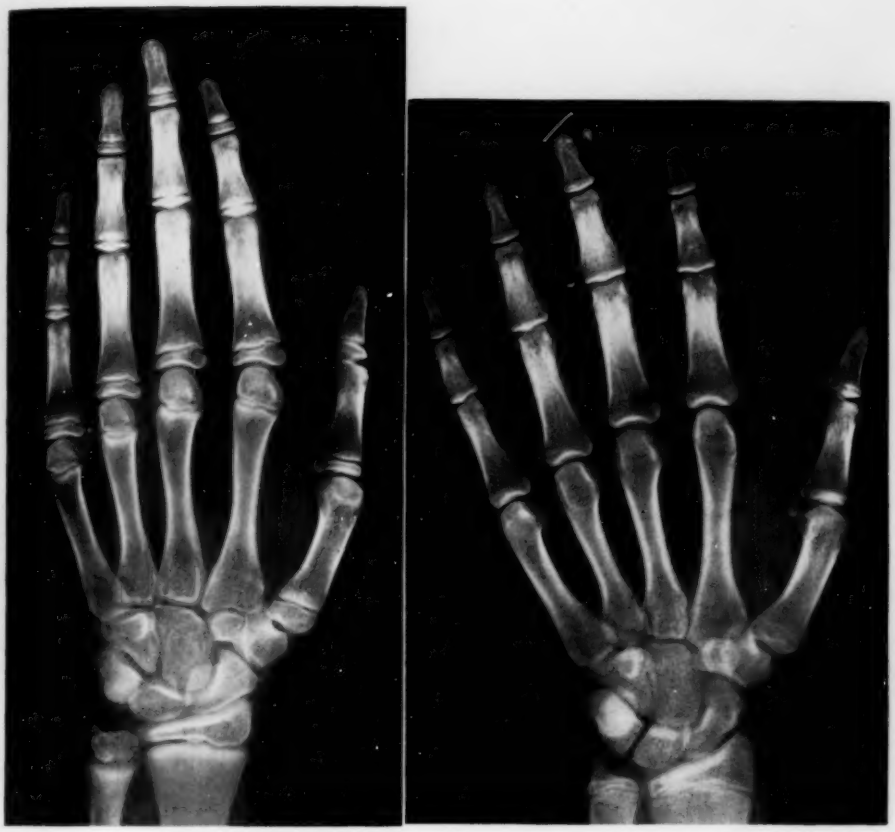
FIG. 2. THREE OF THE 9 SERIES OF MATURITY INDICATORS USED IN THE ASSESSMENT OF THE HIP AND PELVIS. THE TIME TAKEN FOR A BOY TO PASS THROUGH SOME OF THE STAGES SEEMS TO DEPEND PARTIALLY UPON HIS PHYSIQUE. (See text.)

It seemed that *within* each of the three groups there was variation in rate, but in broad terms the fast and slow maturers followed channels which were more or less parallel to each other. When the groups were contrasted, however, this was no longer true. Although the ages of first appearance of ossification and the attainment of Stage 6 were similar in each group, the prolongation of the time taken to pass from Stage 6 to 7 in ectomorphs, and the reduction of this time in meso-

E. G. H. N.

PLATE I. RADIOGRAPHS OF THE HANDS OF TWO 5-YEAR-OLD BOYS. E. G. HAD A SOMATOTYPE OF 117 AND WAS THE MOST ECTOMORPHIC BOY IN THE GROUP. H. N., WITH A SOMATOTYPE OF 261, WAS THE MOST MESOMORPHIC. NOTE THAT THERE IS NO DIFFERENCE IN THE SKELETAL MATURITY OF THE SHORT BONES OF THE HAND, OR OF THE RADIUS. HOWEVER, THE CARPALS OF THE MESOMORPH ARE DISTINCTLY MORE ADVANCED.

Maturity scores by the Oxford Method (uncorrected) for these hands are:
E. G., 29 points H. N., 31 points



E. G. H. N.

PLATE II. RADIOGRAPHS OF THE HANDS OF E. G. AND H. N. AT 14 YEARS OF AGE. NOTE THAT WHILE E. G. SHOWS NO SIGNS OF EPIPHYSEAL CLOSURE, THE PHALANGES, METACARPALS, AND CARPALS OF H. N. ARE MATURE IN THIS RESPECT. THE DELICATE LINEAR BONES OF THE ECTOMORPH ARE IN STRIKING CONTRAST TO THE COMPARATIVELY SQUARE, SQUAT BONES OF THE MESOMORPH. NO STANDARDS ARE YET AVAILABLE FOR ASSESSMENT OF HAND RADIOGRAPHS AT THIS AGE BY THE OXFORD METHOD.

The adult height of E. G., the ectomorph, is 190.5 cm (75 inches) and of H. N., 172.1 cm (67.5 inches).

H. N.

E. G.

PLATE III. RADIOGRAPHS OF HIP-JOINT AND PELVIS OF E. G. AND H. N. AT THE AGE OF 5 YEARS. THERE IS LITTLE DIFFERENCE IN THE SKELETAL MATURITY OF THE HEAD OF FEMUR (STAGE 4), AND THE REGION OF ACETABULUM AND TRIRADIATE CARTILAGE; IN BOTH FILMS THE JUNCTION OF PUBIC AND ISCHIAL RAMI IS AT STAGE 3. HOWEVER, THE MESOMORPH SHOWS A CONSIDERABLE AMOUNT OF OSSIFICATION IN THE GREATER TROCHANTER (STAGE 2), WHEREAS THIS CENTER DOES NOT YET SHOW IN THE ECTOMORPH. THESE TWO CASES ARE FAIRLY TYPICAL OF THE ECTOMORPHS AND MESOMORPHS STUDIED

The maturity score of the two films is: E. G. 16 points; H. N. 18 points.

morphs, meant that the total time elapsing between first appearance and final fusion of the epiphysis was longer in the ectomorphs. But this difference could not be predicted by inspection of the center on the radiograph for Stages 1 through 6.

Inspection of the hand films of the same boys suggested that what is true for the head of the femur may also be true for the epiphyses of the short bones of the hand. Plate I shows the hand of the most ectomorphic boy in the study (somatotype 117) compared with that of the most mesomorphic (somatotype 261) at the age of 5 years. There is no detectable difference between the maturity status of any of the epiphyses in the fingers or the wrist. However, when the same two boys had reached the age of 14 years, all of the epiphyses were already united in the hand of the mesomorph, whereas those of the ectomorph had not yet exhibited any suggestion of union (plate II). In plate III, the hip joints of the same boys are shown, and it will be noted that the head of the femur is equally mature (Stage 4) in both.

Traction epiphysis (*greater trochanter*). The greatest difference between mesomorphs and ectomorphs with respect to the greater trochanter was the time of first appearance of ossification. The average age at which ossification was first seen in the mesomorphs was 46 months and in the ectomorphs 51 months. The figure for the control group was also 46 months (Francis and Werle, '39, found that 74% of the Brush boys they studied had this center ossified by the age of four years); hence, the suggestion here is that appearance in the ectomorphs is delayed. However, by the time the three groups had reached Stage 3, the ectomorphs appeared to have caught up, and the mean ages and range of variation at which Stages 3 through 5 were achieved were strikingly similar. There was a suggestion that final fusion may occur a little earlier in the mesomorph. Delay of appearance of this center in an ectomorph is well shown in plate III, where there is no sign of ossification at the age of 5 years, whereas the mesomorph has already reached Stage 2 at the same age.

Primary center (*fusion of ischial and pubic rami*). It was in the fusion of ischial and pubic rami alone that a steady and parallel difference was maintained among the three groups throughout the maturation process. The mean age for reaching Stage 1 was 34 months for the mesomorphs, 46 months for the ectomorphs, and 41 months for the controls; and the ages for final maturity (Stage 4)

NOT YET SHOW IN THE ECTOMORPH. THESE TWO CASES ARE FAIRLY TYPICAL OF THE ECTOMORPHS AND MESOMORPHS STUDIED
The maturity score of the two films is: E. G. 16 points H. N. 18 points.

in this indicator series were 110 months, 120 months, and 116 months respectively. The fusion of these two rami has no exact parallel in the hand, but it does represent ossification in a primary center. It therefore is interesting that ossification in the carpal bones of the mesomorphs seemed to be, on an average, slightly ahead of that of the ectomorphs. Such a difference can be seen in plate I.

The material is not suitable for any trends to be sought in boys who are predominant in endomorphy. However, when Robinow ('42) subjected the age-order of appearance of the centers of ossification to factor analysis, he found that there were three factors. The first he identified with the round bones, the second with the articular epiphyses, whereas the third he was unable to name. It is not impossible that these factors may be identified with Sheldon's three components. Nevertheless, it is important to realise that the trends we have described were slight, and that the analysis of more comprehensive data may show them to be false.

Rate of Skeletal and Sexual Maturation in Boys Who Are Very Obese, as Reported in the Literature

In the Oxford Child Health Survey studies were made of minor changes in rate of growth in stature, and in rate of skeletal maturation (Acheson and Hewitt, '54; Hewitt, Westropp, and Acheson, '55). It was suggested that if the genetically endowed "growth potential" of a child is accepted as the maximum number of units it can add to its stature for each unit gain in maturity, then at any time when the child's rate of growth is slowed more than its rate of maturation, it fails to fulfill its growth potential. It was shown that poor home circumstances, and even minor illnesses, can interfere with the fulfillment of this growth potential. Wolff ('55) reported observations on a group of 100 children who attended a pediatric clinic in Birmingham, England, because of obesity; in only three did he find evidence of endocrine imbalance or any other gross pathological disorder. He put many of the remainder on a slimming diet, and in those cases in whom this treatment had the desired effect of reducing weight, the rate of increase of stature was also slowed. What is more, there was a direct relationship between the amount of weight loss and the decrease in rate of linear growth. This strongly suggests that the minimum amount of food these children require to fulfill their growth potential will at the same time make them obese. Whether or not the fulfillment

of growth potential in such cases is desirable, the facts suggest that the tendency to obesity in these children is constitutional, or, as Sheldon would put it, they are highly endowed with endomorphy. This conclusion is supported by Stuart ('55) who, when discussing obesity in childhood, wrote "there is a strong genetic predisposition to become obese . . . and this is commonly, though not necessarily, associated with such characteristics as being tall for age. . . ."

It has already been pointed out that Todd deliberately omitted obese children from the main Brush Study group. We therefore decided to examine growth data of obese children in the literature in order to try to determine the contribution of Component I to the rate and pattern of skeletal maturation in childhood. In addition to the work of Wolff ('55, '56), there are reports from Paris (Nobécourt, '37, '38), New York (Bruch, '38), and Copenhagen (Quaade, '55) in which the authors publish comprehensive anthropometric data, and conclude that endocrine imbalance is not the cause of obesity in their respective study groups; they suggest that the condition is more probably due to the constitution of the child, or to a tendency to overeat—or to both. Two hundred and twenty-eight boys were followed in these four centers, and when to these is added Stuart's case ('55), the data from 229 obese boys becomes available for analysis.

1. Skeletal Maturation. Of the four main studies, Bruch's ('38) alone makes any assay of skeletal maturation. She uses a radiograph of the hand as an index, and comparing this with Todd's ('37) standard, concludes that, on average, her obese children of both sexes are unusually fast maturers. It is pertient to point out that Todd's standards were drawn from the same population as our present study group, and that they represented the mean rate of maturation for all Brush children examined up to 1935. Therefore, it is probably legitimate to conclude that Bruch's endomorphic American boys showed a faster rate of skeletal maturation than our own relatively endopenic group of American boys, this despite the fact that the New York children came from a much lower economic stratum than the Cleveland children.

2. Sexual Maturation. It has been shown repeatedly (Flory, '36, Shuttleworth, '38, Buehl and Pyle, '42, Tanner, '55, etc.) that skeletal and sexual maturation are intimately related. Therefore, since precise details of the time of appearance of the pubic hair are available in all four groups, the rate of skeletal maturation can be deduced by esti-

mating the age of onset of puberty. In presenting their data, Nobécourt ('38) and Quaade ('55) use as controls children they themselves have observed in the cities where they practice. Wolff's ('55, '56) controls also come from the same city as his study groups, but were seen, not

TABLE 4

The percentage age-incidence of appearance of pubic hair in 159 obese boys (reported in the literature)

AGE	NOBÉCOURT '38		BRUCH '38		QUAADE '55		WOLFF '55, '56		
	Obese	Control	Obese	Control	Obese	Control	Obese	Control	
10-	—	—	0 (10)		9.1 (11)	0 (40)	50.0 (4)	*Age (years)*	
11-	18.2 (11)	0 (10)	50 (4)		7.2 (14)	7.9 (63)	44.4 (9)		
12-	9.1 (11)	0 (12)	33 (9)		41.7 (12)	15.2 (59)	50.0 (10)	25	*11.9*
13-	15.3 (13)	41.7 (12)	100 (3)		46.2 (13)	53.8 (52)	100.0 (3)	50	*12.9*
14-	37.5 (8)	70.0 (10)			100.0 (1)	84.6 (52)		75	*14.0*
15-	66.7 (9)	80.0 (5)			100.0 (6)	100.0 (25)			
16- 17-	72.7 (11)	100 (1)							
Total No. of Cases	50	50	26	0	57	291	26	664	

Figures in parentheses denote the number of observations at each age. Bruch uses no controls, and Wolff's controls are taken from a study of 664 school boys in Birmingham, England by Hogben, Waterhouse, and Hogben '48. Nobécourt, whose data are partly longitudinal, and Quaade provide controls from the records of children they have examined themselves.

by himself, but by Hogben, Waterhouse, and Hogben ('48) and their co-workers. Bruch ('38) used no control group in her discussion of sexual maturation.

The results of these studies are summarised in table 4, where it will be seen that in each of the controlled groups the obese boys show signs of puberty early, and that there is a higher incidence of pubertal

changes among Bruch's boys aged 11⁻ and 12⁻ than in any of the control groups.[3] This general indication that early puberty may be associated with childhood obesity is supported by comparing the figures in table 4 with those reported by Tanner ('55) for 188 British military cadets whose mean endowment of endomorphy was as low as 3.09. He found that only 19.8% of them had pubic hair by the age of 12 years and 58.3% by the age of 13.

3. Growth Curves. Another approach to this problem is to compare the growth curves of the various groups of boys. Faster than average skeletal maturation is associated with an early pre-pubertal growth spurt. In boys the effect of this is to make the average stature of early maturers, aged about 8 to 11 years, greater than that of a group of slower maturers of the same age. Mean growth curves of the four groups of obese boys are compared with the controls chosen by the respective authors in figure 3. Nobécourt ('37) and Quaade ('55) again provided their own controls, and Bruch ('38) compared the stature of her boys with the tables of Burgess ('37). Wolff ('55) used two different sets of controls in his paper, one a group of American boys and the second the sons of well-to-do British parents studied by Widdowson ('47). Because they were racially more similar to Wolff's group, the latter were used for the present purpose. It should be borne in mind that these controls were economically more favored than Wolff's study group, and therefore any height advantage the latter might have over controls living in an identical environment would not necessarily be apparent. Nevertheless, it will be seen that, except for the Danish group, the obese boys age for age become progressively somewhat taller than the controls, the difference being maximal between the 9th and 11th years; then their lead falls off, until by the age of 13 years the controls have caught up and passed the obese groups. Stuart's ('55) case (not shown in figure 3) follows the same pattern.

In figure 4 mean stature for age for all the 229 boys is compared with that of the 22 most predominant ectomorphs and the 27 most predominant mesomorphs in our own study group. This also shows that obese boys apparently mature more rapidly and that they appear to become smaller adults. This is consistent with Sheldon's own data (Sheldon, Stevens and Tucker, '40), as is demonstrated in table 5.

[3] The Copenhagen percentages are estimated from a regrouping of Quaades' ('55) data.

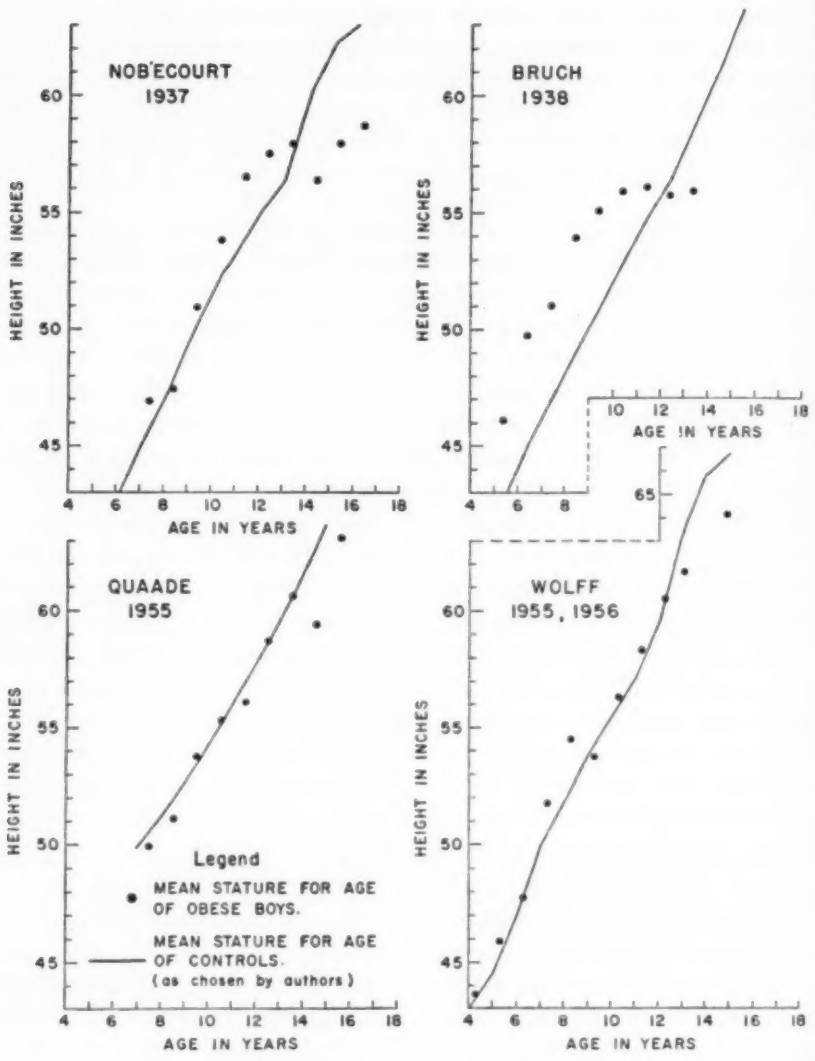


FIG. 3. THE MEAN STATURE OF FOUR GROUPS OF OBESE BOYS REPORTED IN THE LITERATURE, COMPARED WITH CONTROLS OF THE RESPECTIVE AUTHOR'S CHOOSING. NOBÉCOURT AND QUAADE PROVIDED THEIR OWN CONTROL DATA, BRUCH USED THOSE OF BURGESS ('37), AND WOLFF THOSE OF WIDDOWSON ('47).

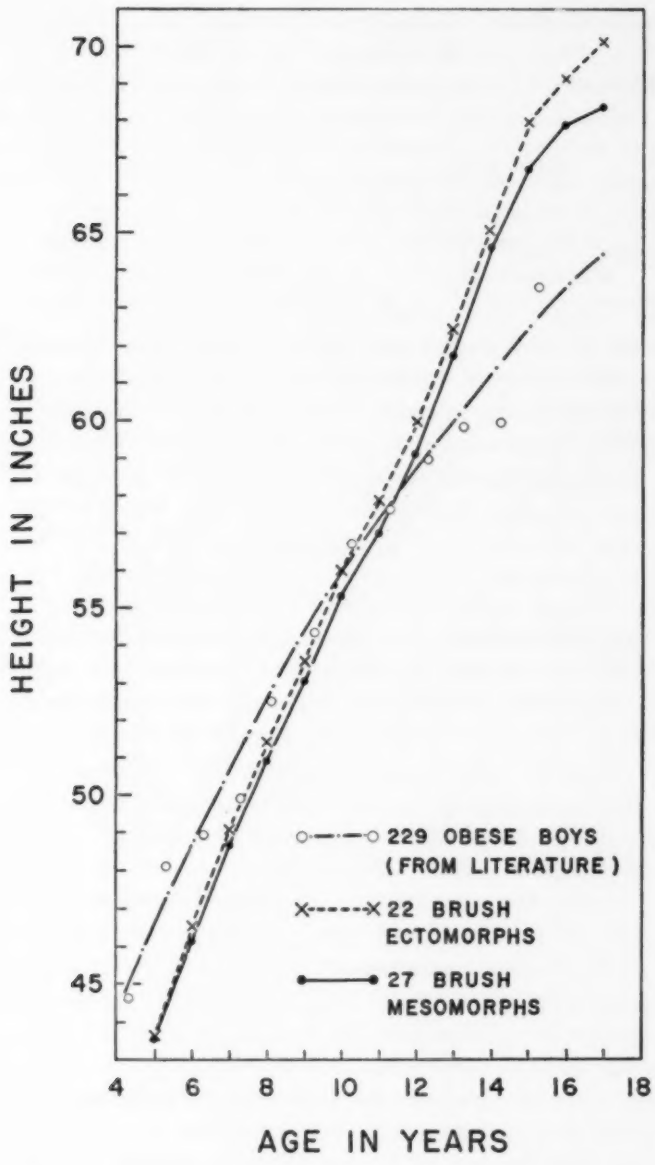


FIG. 4. MEAN STATURE OF ALL THE CASES SHOWN IN FIGURE 3 COMBINED, COMPARED WITH THE BRUSH ECTOMORPHS AND MESOMORPHS.

TABLE 5

The mean adult stature of groups of men showing a rating of over 5 in each of the somatotype components

(Computed from the data of Sheldon, Stevens, and Tucker '40)

COMPONENT	NUMBER OF CASES	MEAN STATURE (IN INCHES)
I (Endomorphy)	516	67.94
II (Mesomorphy)	1,046	68.42
III (Ectomorphy)	862	70.46

With the possible exception of Bruch's data, none of these studies taken by itself shows a relationship between endomorphy and rapid skeletal maturation which is statistically significant. Nevertheless, there is a consistent trend for the fastest maturers to be found among boys who are predominantly endomorphic.

DISCUSSION

Interpretation of Findings

The Brush Foundation data are probably the best suited of all the growth studies so far completed for an analysis of this type. It has been shown repeatedly that adverse enviroment can slow skeletal maturation (Stettner, '20, '21; Greulich, '51; Beresowski and Lundie, '52; De Wijn, '53; Greulich, Crismon, and Turner, '53). Adverse environment can also cause a dissociation of the relationship between skeletal maturation and growth, and therefore bring about stunting (Acheson and Hewitt, '54). Since the Brush children were all from prosperous Cleveland homes, the economic environment was probably as constant as it is ever likely to be in any growth study. Nevertheless, different environmental effects almost certainly were experienced by the children. For instance, it was shown in the Oxford Study that the ordinary intercurrent illnesses of childhood could cause a dissociation of the relationship between skeletal maturation and growth, and this was similar to that caused by poor economic circumstances. Furthermore, there was no indication that a child so affected made any compensation for this stunting up until the age of 5 years (Hewitt, Westropp, and Acheson, '55). Stuart ('56), in a longitudial study of a group of Boston children at the Harvard School of Public Health, has accumulated some evidence

suggesting that emotional disturbances may be associated with or followed by delays in the progress of physical development. In one boy, a marked psychological reaction to his mother's death and to the resulting broken home was followed by profound retardation in his physical growth and adolescent development which extended over a number of years. The Brush children certainly suffered childhood diseases, and some of them were also subjected to emotional disturbances. Unforunately the records are not suitable for a detailed analysis of the influence of these factors, but we must assume that in many of the children interference with development did occur.

In this paper we have assembled evidence which suggests that there is a relationship between physique and rate of maturation. This relationship is presumably genetically determined, but even in such highly selected material it must have been progressively masked and distorted by the insults and stresses of the environment. All the evidence suggests that this distortion always takes the form of slowing down maturation and slowing down the growth rate even more—that is to say, reducing final adult height. Thus, upon the basic genetic tendency for slow maturation to be associated with great adult height is superimposed environmental tendency for slowed maturation to be associated with stunted adults (the word "stunted" being used in a comparative sense). Except in the case of children who show opaque lines at the metaphyses of their long bones on the radiograph (Harris's Lines), it is unfortunately impossible, at the moment, to distinguish between the naturally slow maturer and the slowed maturer. We have already shown that the naturally slow maturer is often predominantly ectomorphic. The position of any point in the scattergram in figure 1 could therefore depend on two factors. The first is the amount of ectomorphy in the individual's make-up; a considerable amount of this would tend to put him in the bottom right hand corner of the chart. The second is the effect the environment has had upon him (this in turn depends both upon the severity of his experience and his ability to withstand this experience); stresses of this type would tend to put him in the bottom left hand corner of the chart. Thus the mesomorph presumably appears in the top left hand corner of the chart, because he lacks the slowing effect which is associated with ectomorphy, and because he has not shown undue ill effects from his experience with his environment. Certainly, the mean value of 2.02 for ectomorphy in the mesomorphs of our group is very low. The computation of partial linear regressions in our

material showed that a moderate endowment of endomorphy contributed little to the general rate of skeletal maturation as calculated in this study, so that Component I has evidently had little to do with the location of the points in figure 1. This is not, at first sight, consistent with our review of the literature, from which we concluded that the fastest maturers of all may be found among those with a high endowment of endomorphy.

This apparent inconsistency may be due to several things. To begin with, the regressions between rate of maturation and physique may not be linear, but may take a more complex form. Second, a true expression of the rate of maturation presents a difficult fundamental problem. The construction of the index we have used rested on the hypothesis, previously widely accepted, that the rate of maturation in the majority of individual children bears a constant relationship to the mean rate of maturation. It was realised from the outset that this hypothesis would be false in those children who suffered a setback in physical development through illness or some similar cause. Our finding that the rate of maturation in each indicator series may vary according to physique suggests that there may also be cases in which, because of physique, the index may not reflect the whole truth. Nevertheless, this fortifies our conclusions, for trends which have been detected with a clumsy instrument will often become obvious relationships when delicate techniques are evolved.

Application of Findings

One of the principal purposes of all growth studies has been to try to learn enough of the factors controlling physical development to enable the physician to evaluate the developmental status of an individual child. It has long been realized that height for age tables or weight for age tables are inadequate for this purpose. However, Wetzel ('41), by combining the three variables (height, weight, and age) produced a simple chart which was a definite step forward. If our present findings are valid, somatotype assessment and knowledge of skeletal maturity status of the child can also be powerful aids to the pediatrician in the diagnosis of minor deviations from the healthy patterns of physical development.

By expressing a child's height in terms of its skeletal maturity status at any age, a prediction of its adult height can be made. This procedure is the basis of the height prediction tables of Bayley and Pinneau ('52),

and of Bayley's ('56) more recent growth curves. However, the present data suggest that we can go further than this. Supposing that endomorphy is associated with rapid maturation and rather short adult stature, we can then allow for this when we are trying to decide whether a fat boy is growing normally. It is interesting to note that when Bruch ('38) plotted "height age" against "skeletal age" for obese boys, she found it to be below average, although both stature and skeletal age when plotted against chronological age were above average for the same group of boys. In this way she showed that her study group were growing quickly and maturing quickly, but that they were going to be small adults.

Probably the best example of these principles would be the case of the delicately constructed, ectomorphic boy. Because he is highly endowed with the third somatotype component, there would be no need for concern if he were found to be maturing rather more slowly than average, nor would it necessarily be disturbing to find that his stature were rather less than that of children of the same age. However, if his stature was plotted against his skeletal maturity status and found to be less than average, this finding would strongly suggest faulty growth. Ectomorphy seems to be associated with greater than average adult stature, and therefore an ectomorphic boy should be taller than the average for his skeletal maturity status throughout the entire developmental period.

Ideally, it should be possible to draw up tables in which stature predictions can be made for all ages, allowing for all these variables. At the moment, however, there are far too many unknown factors for this project to be undertaken. Figure 1 shows that there is a wide variation among the ectomorphic and mesomorphic groups themselves. Part of this variation is certainly due to the environment, but there may be other factors as well. What is the effect of race? There is some evidence that the southern Italian woman matures more quickly than the Scandinavian woman, for instance. Is this simply because the former are usually highly endowed with endomorphy and the latter more ectomorphic in build, or does their ethnic pattern of itself contribute to the difference? Can climate have a direct effect on growth patterns? Again, it has been shown that adverse environment affects the development of the sexes differently, and that the temporary effect, at least, is more profound upon the boy than it is upon the girl (Greulich, '51; Greulich, Crismon, and Turner, '53; Acheson, Hewitt,

Westropp, and Macintyre, '56). Does the resilience of any individual boy depend upon the amount of any single somatotype component, or even upon a reasonably equal distribution of all three components? Until these questions can be answered there seems to be little point in attempting to improve upon the standards of Wetzel ('41) or of Bayley ('56). Nevertheless, it may be helpful to bear in mind the possible effect of physique when making a clinical appraisal.

SUMMARY

One hundred and twenty-eight boys, originally followed in the Brush Foundation Growth Study, were again seen in 1951. Each had his height and weight recorded and was photographed for somatotyping. Their skeletal maturity, together with that of 97 other Brush boys, amounting to a total of 225 in all, was assessed, by the Oxford Method, from serial radiographs of hip and pelvis. When the boys who were somatotyped were divided into four groups according to rate of skeletal maturation during the growing period, it was found that the linear regression between Component III (ectomorphy) and rate of maturation differed significantly from zero, Component III being highest among the slow maturers. There was a tendency, which was not significant, for Component I (endomorphy) and Component II (mesomorphy) to be higher among the faster maturers.

When the 22 boys with over 5 in Component III were compared with the 25 boys with over 5 in Component II, it was found that the former were significantly taller and slower maturing than the latter. A detailed comparison was made between the maturational time-pattern in an articular epiphysis (head of femur), traction epiphysis (greater trochanter), and primary center (junction of pelvic and ischial rami) in the extreme ectomorphs and extreme mesomorphs. The numbers were too few at any age for statistical analysis, but it seemed that these time-patterns did vary with physique.

A critical analysis of the literature suggested that the fastest maturers may be found among those with a high endowment of Component I.

It is concluded that there is some basic relationship between physique and skeletal (or sexual) maturation, which is genetically controlled. However, it is emphasized that this relationship is masked and distorted by the effects of the environment. Finally, it is suggested that con-

sideration of physical build may be of aid to the physician in his attempt to diagnose deviations from normal patterns of growth and skeletal maturation in children.

ACKNOWLEDGMENTS

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THE EFFECT OF SEX, BIRTH RANK AND BIRTH WEIGHT ON GROWTH IN THE FIRST YEAR OF LIFE[1]

BY EVA J. SALBER[2]

GROWTH in the first postnatal year, of babies of the four racial groups attending municipal child welfare clinics in Durban has been discussed previously (Salber, '57). This article analyses the effect of sex, birth rank and birth weight on that growth.

MATERIAL USED AND METHOD OF ANALYSIS

The same sample of babies is used here as was used in the previous paper, but the children are divided into Rank 1 (first-born) and Rank 2+ (later born), the numbers being:

EUROPEAN	RANK 1	RANK 2+	TOTAL
Male	458	658	1116
Female	417	563	980
Total	875	1221	2096
COLORED			
Male	79	205	284
Female	85	210	295
Total	164	415	579

[1] This paper forms part of the material of an M. D. Thesis, University of Cape Town.

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BANTU	RANK 1	RANK 2+	TOTAL
Male	182	446	628
Female	150	525	675
Total	332	971	1303
INDIAN			
Male	80	179	259
Female	70	180	250
Total	150	359	509

The European babies are also divided into 5 different groups according to their weight at birth:

Up to 4 lbs 15 oz
5 lbs 0 oz to 5 lbs 15 oz
6 lbs 0 oz to 6 lbs 15 oz
7 lbs 0 oz to 7 lbs 15 oz
8 lbs and over.

Mean weights and standard deviation are worked out for each week of life from 2–52 weeks for boys and girls, Rank 1 and 2+ separtely in each birth weight group.

Since there are insufficient data on birth weights for the non-European groups and their numbers of first born babies attending clinic are also small, it is possible to analyse the effect of rank and birth weight in detail, and to graph the results only for the European group.

Rates of growth (increments) are also presented for boys and girls Rank 1 and Rank 2+ separately. These are shown at four-week intervals and are also expressed as number of ounces gained per week.

RESULTS

A. *Effect of Sex on Growth.*

1. *Mean Weights during the Year.*

Tables of mean weights at each week of life from 2–52 weeks for each of the racial groups. boys and girls separately, have been shown already (Salber, '57) and do not need to be repeated here. The boys'

weight are higher than those of girls throughout the year but this is to be expected because boys weigh more than girls at birth. However, the difference between them is greater at the end of the year than at the beginning of the year (table 1).

TABLE 1

Weight differences between boys and girls of four racial groups at selected ages

BOYS–GIRLS	3 weeks (lbs)	13 weeks (3 mths) (lbs)	26 weeks (6 mths) (lbs)	39 weeks (9 mths) (lbs)	50 weeks (lbs)
European	0.39	0.66	1.03	1.06	1.34
Colored	0.40	0.91	1.24	1.34	1.21
Bantu	0.32	0.79	0.99	1.33	0.87
Indian	0.63	0.97	1.64	1.17	0.84

Examination of this table reveals that the difference in weight between boys and girls at three weeks is almost the same for European, Colored and Bantu, with Indians having the greatest difference. At 50 weeks difference is greatest for Europeans and least for Indians. European boys' weight rise steadily above those of girls throughout the year, Colored boys do the same until 39 weeks with a slight decline thereafter. The weight difference between Bantu girls and boys is less marked than for Colored until 39 weeks when it is the same, but after that the Bantu decline is steeper. Indians show the greatest weight disparity between boys and girls of all the racial groups up to 26 weeks, followed by an equally sharp drop thereafter so that at 50 weeks they have the least difference between boys and girls of all the groups.

2. *Shape of Growth Curves.*

The effect of sex on growth can be studied most simply by examination of the graphs of growth in the first year of life (Salber, '57) and by superimposing the graph for the girls on the graph for the boys in each race group. In general the shape of the growth curves in the first year of life is similar for boys and girls.

European. Growth curves of boys and girls run parallel to each other up to 10 weeks of age, after which there is a very gradual increase in the difference between them until the end of the year, with the boys consistently putting on slightly more weight.

Colored. Boys weights start rising faster than girls from two weeks of age, with a gradually increasing difference up to 33 weeks, after which the gap narrows very gradually but not sufficiently to enable the girls to catch up to the boys by the end of the year.

Bantu. Curves of growth of boys and girls are parallel up to 6 weeks, then the difference between boys and girls gradually increases up to about 6 months, weight of boys being greater than of girls. From 6 months till about 44 weeks there is no further increase in difference between the sexes, and after 44 weeks the gap narrows until at 49–50 weeks the difference in weights between boys and girls is virtually the same as at the beginning of the year.

Indian. Growth curves of Indian boys and girls are parallel to each other up to 7 weeks, from 7 to 32 weeks the difference narrows until by 51 weeks the difference is the same as at the beginning of the year.

In general it appears that non-European boys grow faster than girls during the first 6–8 months of life, and girls faster than boys during the rest of the year. European boys, however, consistently grow faster than girls throughout the year.

3. *Rate of Growth (increments).*

Tables showing rate of growth for boys and girls separately at four-week intervals were shown previously and commented on. (Salber, '57). The effect of sex per se on growth rate is now discussed.

European rate of growth is consistently higher for boys from 2–52 weeks, but the difference in growth rate is not as marked during the period 20–32 weeks as it is during the rest of the year. The total gain in weight for the sexes is as follows:

TOTAL GAIN	BOYS	GIRLS
2–52 weeks	14.69 lbs	13.97 lbs

Colored rate of growth is higher for boys than girls for most of the year, but from 36 weeks, with slight irregularities, girls appear to grow faster than boys.

TOTAL GAIN	BOYS	GIRLS
2–52 weeks	13.05 lbs	11.46 lbs

Bantu growth rate is higher for boys than girls with the exception of the period between 40–48 weeks when girls grow faster.

TOTAL GAIN	BOYS	GIRLS
2–52 weeks	14.30 lbs	12.64 lbs

Indian boys grow faster than girls from 2–32 weeks, but from 32 weeks onwards girls grow faster than boys.

TOTAL GAIN	BOYS	GIRLS
2–52 weeks	11.62 lbs	11.91 lbs

The same point emerges once again—the effect of sex on growth is not quite the same in the European and non-European races. In the non-European races there seems to be a period late in the second half of the first year during which the girls grow faster than the boys. Among Europeans this is not so, and boys grow consistently faster than girls.

B. *Effect of Birth Rank on Growth.*

Only in the European group are there sufficient data to analyse the effect of rank on growth fully, as the numbers of Rank 1 babies in the other groups are inadequate for analysis for half the year.

1. *Europeans.*

(a) Figures of mean weights from 2–52 weeks for ranks separately (Salber, '57) and chart 1 show that in European babies the rate of growth of Rank 1 (first born) babies, both boys and girls, is greater than that of Rank 2+ babies, since, although they start life with a lower birth weight (Salber and Bradshaw, '51), they end up heavier at the end of the year.

(b) At two weeks, Rank 1 girls weigh 0.49 lbs less than Rank 2+ girls, but they overtake Rank 2+ girls at 21 weeks and by 52 weeks are 0.38 lbs heavier. This means that from 2–52 weeks Rank 1 girls have actually gained 0.87 lbs more than Rank 2+ girls.

(c) At two weeks, Rank 1 boys weigh 0.21 lbs less than Rank 2+ boys, and do not overtake them until 42 weeks, but by 52 weeks they are 0.47 lbs heavier, thus gaining 0.68 lbs more during the year than Rank 2+ boys.

2. In the *Colored* group, information on Rank 1 babies is only available up to 27–28 weeks. By this time Rank 1 boys have not overtaken Rank 2+ boys. Rank 1 girls, however, overtake Rank 2+ girls at 17 weeks.

3. The *Bantu* group has information on Rank 1 babies up to 37–38 weeks. Rank 1 Bantu boys overtake Rank 2+ boys at 17 weeks, whereas Rank 1 girls overtake Rank 2+ girls at 29 weeks.

4. *Indian* group information on Rank 1 babies is complete up to 27 weeks. During this period the first born boys have not overtaken later born boys but the girls have done so at 24 weeks.

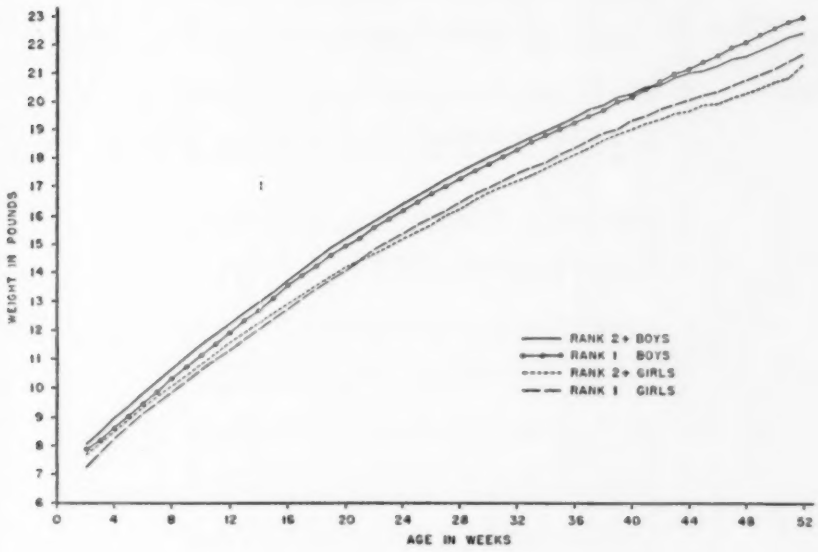

CHART 1.

GROWTH CURVES IN THE FIRST YEAR OF LIFE ACCORDING TO BIRTH RANK (EUROPEAN GIRLS AND BOYS SHOWING RANKS 1 AND 2 SEPARATELY).

5. In general, Rank 1 girls overtake Rank 2+ girls faster than Rank 1 boys overtake Rank 2+ boys. In the Bantu group, however, the position is reversed with Rank 1 boys overtaking Rank 2+ boys sooner than do the girls.

6. Examination of rates of growth (tables 2a and b) also show that in each racial group the gain per week is greater in Rank 1 than in Rank 2+ babies.

7. In European, Colored and Indian babies the difference in rate of growth between the ranks is greater for girls than for boys, but in the Bantu the difference appears to be greater in the boys.

TABLE 2a

Increments of Weight at 4 week intervals (Boys)

	Rank 1								Rank 2+								All Ranks							
	European		Colored		Bantu		Indian		European		Colored		Bantu		Indian		European		Colored		Bantu		Indian	
	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week
Birth Weight	7.35	—	—	—	—	—	—	—	7.63	—	—	—	—	—	—	—	7.48	—	—	—	—	—	—	—
0–2 Weeks	.59	—	—	—	—	—	—	—	.43	—	—	—	—	—	—	—	.50	—	—	—	—	—	—	—
2–4	.81	6.5	—	—	1.08	8.6	—	—	.90	7.2	1.11	8.9	1.26	10.1	—	—	.85	6.8	1.01	8.1	1.20	9.6	.85*	6.8
4–8	1.68	6.7	1.80	7.2	2.47	9.9	—	—	1.67	6.7	1.84	7.4	2.29	9.2	1.67	6.7	1.67	6.7	1.82	7.3	2.33	9.3	1.70	6.8
8–12	1.60	6.4	1.57	6.3	2.03	8.1	1.58	6.3	1.59	6.4	1.52	6.0	1.83	7.3	1.41	5.6	1.59	6.4	1.56	6.2	1.92	7.7	1.43	5.7
12–16	1.62	6.5	1.47	5.9	1.58	6.3	1.22	4.9	1.53	6.1	1.07	4.3	1.44	5.8	1.29	5.2	1.57	6.3	1.16	4.6	1.49	6.0	1.28	5.1
16–20	1.41	5.6	1.44	5.8	1.54	6.2	1.37	5.5	1.43	5.7	1.29	5.2	1.15	4.6	1.01	4.0	1.42	5.7	1.34	5.4	1.23	4.9	1.10	4.4
20–24	1.25	5.0	0.84	3.4	0.85	3.4	0.58	2.3	1.22	4.9	1.07	4.3	0.98	3.9	0.98	3.9	1.23	4.9	0.99	4.0	0.94	3.8	0.87	3.5
24–28	1.11	4.4	—	—	0.87	3.5	1.04	4.2	1.15	4.6	1.00	4.0	0.92	3.7	0.89	3.6	1.14	4.6	0.96	3.8	0.93	3.7	0.93	3.7
28–32	1.10	4.4	—	—	0.82	3.3	0.90	3.6	0.97	3.9	0.97	3.9	0.62	2.5	0.72	2.9	1.03	4.1	0.94	3.8	0.66	2.6	0.74	3.0
32–36	0.89	3.6	—	—	0.62	2.5	—	—	0.96	3.8	0.44	1.8	0.66	2.6	0.12	0.5	0.92	3.7	0.67	2.7	0.63	2.5	0.36	1.4
36–40	0.95	3.8	—	—	—	—	—	—	0.89	3.6	0.58	2.3	0.81	3.2	0.42	1.7	0.92	3.7	0.52	2.1	0.74	3.0	0.41	1.6
40–44	0.92	3.7	—	—	—	—	—	—	0.68	2.7	0.39	1.6	0.01	0	0.61	2.4	0.80	3.2	0.38	1.5	0.04	0.2	0.47	1.9
44–48	0.93	3.7	—	—	—	—	—	—	0.60	2.4	0.28	1.1	0.56	2.2	0.35	1.4	0.74	3.0	0.50	2.0	0.54	2.2	0.45	1.8
48–52	0.82	3.3	—	—	—	—	—	—	0.82	3.3	1.50	6.0	1.36	5.4	—	—	0.81	3.2	1.20	4.8	1.65	6.6	1.03	4.1
48–50	0.44	3.3	—	—	—	—	—	—	0.44	3.5	0.62	5.0	0.41	3.3	—	—	0.44	3.5	0.49	3.9	0.45	3.6	0.22	1.7
Total 2–52	15.09	—	—	—	—	—	—	—	14.41	—	13.06	—	13.89	—	—	—	14.09	—	13.05	—	14.30	—	11.62	—
2–50 Weeks	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	14.32	—	12.35	—	13.10	—	10.81	—

* Assuming the gain per week for 2–4 weeks to be at least as great as that for 4–8 weeks.

TABLE 2b

Increments of weight at ¼ week intervals (Girls)

	Rank 1								Rank 2+								All Ranks							
	European		Colored		Bantu		Indian		European		Colored		Bantu		Indian		European		Colored		Bantu		Indian	
	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week	Incr. (lb)	oz per week
Birth Weight	7.01	—	—	—	—	—	—	—	7.37	—	—	—	—	—	—	—	7.20	—	—	—	—	—	—	—
0–2 Weeks	0.24	1.9	—	—	—	—	—	—	0.37	3.0	—	—	—	—	—	—	0.35	2.6	—	—	—	—	—	—
2–4	0.97	7.8	—	—	1.27	10.2	—	—	0.84	6.7	0.61	4.9	1.16	9.3	—	—	0.88	7.0	0.67	5.4	1.17	9.4	0.72*	5.7
4–8	1.66	6.6	1.68	6.7	2.19	8.8	—	—	1.53	6.1	1.58	6.3	1.98	7.9	1.54	6.2	1.58	6.3	1.60	6.4	2.05	8.2	1.43	5.7
8–12	1.48	5.9	1.51	6.0	1.84	7.4	1.60	6.4	1.44	5.8	1.36	5.4	1.72	6.9	1.22	4.9	1.45	5.8	1.41	5.6	1.73	6.9	1.26	5.0
12–16	1.41	5.6	1.22	4.9	1.44	5.8	1.16	4.6	1.39	5.6	1.11	4.4	1.45	5.8	1.06	4.2	1.40	5.6	1.14	4.6	1.45	5.8	1.08	4.3
16–20	1.36	5.4	1.38	5.5	1.08	4.3	0.79	3.2	1.21	4.8	1.14	4.6	1.04	4.2	0.66	2.6	1.28	5.1	1.22	4.9	1.05	4.2	0.70	2.8
20–24	1.25	5.0	1.00	4.0	1.11	4.4	1.04	4.2	1.11	4.4	0.93	3.7	1.06	4.2	0.92	3.7	1.18	4.7	0.90	3.6	1.07	4.3	0.97	3.9
24–28	1.09	4.4	—	—	0.77	3.1	—	—	1.09	4.4	0.97	3.9	0.69	2.8	0.69	2.8	1.09	4.4	1.03	4.1	0.71	2.8	0.76	3.0
28–32	1.04	4.2	—	—	1.05	4.2	—	—	0.90	3.6	0.50	2.0	0.77	3.1	0.73	2.9	0.97	3.9	0.62	2.5	0.83	3.3	0.74	3.0
32–36	0.95	3.8	—	—	0.32	1.3	—	—	0.96	3.8	0.66	2.6	0.55	2.2	0.51	2.0	0.95	3.8	0.63	2.5	0.50	2.0	0.55	2.2
36–40	0.94	3.8	—	—	—	—	—	—	0.86	3.4	0.46	1.8	0.70	2.8	0.70	2.8	0.91	3.6	0.82	3.3	0.60	2.4	0.75	3.0
40–44	0.74	3.0	—	—	—	—	—	—	0.59	2.4	0.82	3.3	—.05	—.2	0.24	1.0	0.66	2.6	0.63	2.5	0.20	0.8	0.39	1.6
44–48	0.68	2.7	—	—	—	—	—	—	0.64	2.6	0.01	0	0.92	3.7	0.50	2.0	0.65	2.6	0.07	0.3	0.84	3.4	0.62	2.5
48–52	0.90	3.6	—	—	—	—	—	—	1.04	4.2	0.70	2.8	0.20	0.8	1.44	5.8	0.97	3.9	0.72	2.9	0.44	1.8	1.94	7.8
48–50	0.40	3.2	—	—	—	—	—	—	0.41	3.3	0.52	4.2	0.29	2.3	0.40	3.2	0.41	3.3	0.49	3.9	0.34	2.7	0.46	3.7
Total 2–52	14.47	—	—	—	—	—	—	—	13.60	—	10.85	—	12.19	—	—	—	13.97	—	11.46	—	12.64	—	11.91	—
2–50 Weeks	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13.41	—	11.23	—	12.54	—	10.43	—

* Assuming the gain per week for 2–4 weeks to be at least as great as that for 4–8 weeks.

C. *Effect of Birth Weight on Growth.*

Sufficient information on birth weight is available in the European group only (in the other groups birth weight is unknown for $\frac{1}{2}$-$\frac{3}{4}$ of each group). The European group is divided into 5 birth weight groups as mentioned earlier, but since the numbers of cases up to 4 lbs 15 oz in weight and 5 lbs 0 oz to 5 lbs 15 oz are too small for separate analysis, these two groups are combined. Table 3 shows the mean weights, boys and girls separately, for the different birth weight groups, all ranks combined.

From charts 2 and 3, which are the pictorial representation of table 3, it can be seen that:

1. Because of their superior birth weight, heavy babies at birth are heavier at the end of the year than babies who are light at birth. This is seen in each successive birth weight group.

2. Birth weight appears to have no effect on the gain in weight during the first year.

3. This means that the rate of growth is relatively greater for lighter babies.

4. These remarks apply equally well to both boys and girls.

DISCUSSION

Effect of Sex on Growth in First Postnatal Year.

Almost all investigators of postnatal growth give separate figures for boys and girls and invariably the boys' weight are greater than those of the girls. This may be because boys weigh more than girls at birth, or because they actually grow faster. In fact, both factors appear to play a part.

Simpson ('52) and Hammond ('52) both found that boys gained on average 1 lb more than girls during the year.

Thomson ('54) shows that in addition to gaining weight more rapidly over the year, the pattern of weight gain in boys is different. They appear to forge ahead more rapidly in the first 12 weeks than subsequently. Thompson ('54) points out that although male infants are larger than female infants of the same age and although their growth increments tend to be larger, the percentage rate of growth does not in general differ significantly in the two sexes. Hill and Magee ('38) also found that though the weight increment of boys

TABLE 3

Mean weights (in pounds) of European infants from 2–52 weeks
All ranks according to birth weight

WEEK	4 and 5		6		7		8	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
2			7.05	7.01	7.79	7.62	8.93	8.73
3	6.30	6.35	7.49	7.41	8.26	8.06	9.34	9.11
4	6.83	6.85	7.96	7.81	8.71	8.50	9.79	9.52
5	7.25	7.22	8.42	8.21	9.18	8.92	10.21	9.92
6	7.68	7.62	8.88	8.64	9.62	9.34	10.63	10.32
7	8.10	8.00	9.33	9.04	10.05	9.73	11.06	10.71
8	8.47	8.34	9.74	9.45	10.50	10.12	11.46	11.06
9	8.89	8.77	10.14	9.83	10.91	10.50	11.87	11.43
10	9.25	9.11	10.55	10.23	11.31	10.87	12.27	11.78
11	9.69	9.47	10.93	10.56	11.71	11.24	12.67	12.10
12	10.09	9.82	11.33	10.93	12.12	11.61	13.07	12.47
13	10.53	10.20	11.75	11.23	12.51	11.97	13.43	12.84
14	10.92	10.53	12.18	11.58	12.89	12.33	13.81	13.18
15	11.33	10.90	12.55	11.88	13.30	12.69	14.18	13.53
16	11.67	11.25	12.95	12.22	13.69	13.02	14.56	13.88
17	11.99	11.60	13.31	12.55	14.07	13.37	14.92	14.20
18	12.40	11.90	13.64	12.92	14.41	13.69	15.29	14.52
19	12.78	12.17	13.93	13.21	14.78	14.02	15.63	14.87
20	13.17	12.44	14.30	13.53	15.12	14.36	15.99	15.18
21	13.48	12.72	14.58	13.85	15.45	14.65	16.32	15.50
22	13.85	12.99	14.83	14.12	15.76	14.96	16.64	15.78
23	14.14	13.21	15.10	14.41	16.07	15.30	16.97	16.04
24	14.46	13.60	15.39	14.72	16.36	15.61	17.32	16.26
25	14.73	13.83	15.70	15.00	16.64	15.85	17.59	16.53
26	15.00	14.10	15.99	15.27	16.93	16.17	17.90	16.79
27	15.31	14.42	16.28	15.55	17.22	16.44	18.17	17.07
28	15.51	14.82	16.60	15.79	17.51	16.69	18.45	17.35
29	15.79	15.00	16.85	16.01	17.80	16.94	18.70	17.61
30	16.01	15.29	17.05	16.26	18.10	17.22	18.99	17.86
31	16.31	15.52	17.30	16.50	18.36	17.48	19.22	18.12
32	16.53	15.67	17.67	16.72	18.54	17.73	19.47	18.30
33	16.78	15.92	17.86	16.94	18.80	17.93	19.76	18.49
34	16.96	16.19	18.12	17.20	19.00	18.15	19.94	18.75
35	17.31	16.44	18.38	17.44	19.20	18.42	20.16	19.00
36	17.54	16.73	18.61	17.68	19.41	18.66	20.38	19.19
37	17.75	17.02	18.76	17.95	19.73	18.84	20.62	19.42
38	18.05	17.14	19.02	18.19	19.95	19.12	20.73	19.73
39	18.25	17.47	19.21	18.44	20.22	19.33	21.07	19.94
40	18.43	17.50	19.46	18.63	20.45	19.51	21.23	20.16
41	18.59	17.79	19.73	18.80	20.68	19.72	21.43	20.36
42	18.68	17.87	19.95	18.97	20.86	19.88	21.61	20.54
43	18.85	18.12	20.10	19.17	21.14	20.05	21.87	20.72
44	19.11	18.11	20.26	19.33	21.28	20.24	22.03	20.80
45	19.16	18.29	20.42	19.55	21.51	20.43	22.20	20.91
46	19.34	18.33	20.53	19.75	21.66	20.52	22.50	21.04
47	19.73	18.66	20.77	19.94	21.86	20.75	22.64	21.23
48	19.88	18.68	21.09	20.09	21.93	20.91	22.85	21.36
49	20.01	19.01	21.39	20.18	22.22	21.13	23.03	21.60
50	20.32	18.94	21.54	20.34	22.31	21.31	23.36	21.88
51	20.46		21.73	20.43	22.51	21.59	23.63	22.14
52	20.86		21.62	20.71	22.50	21.86	24.01	22.60

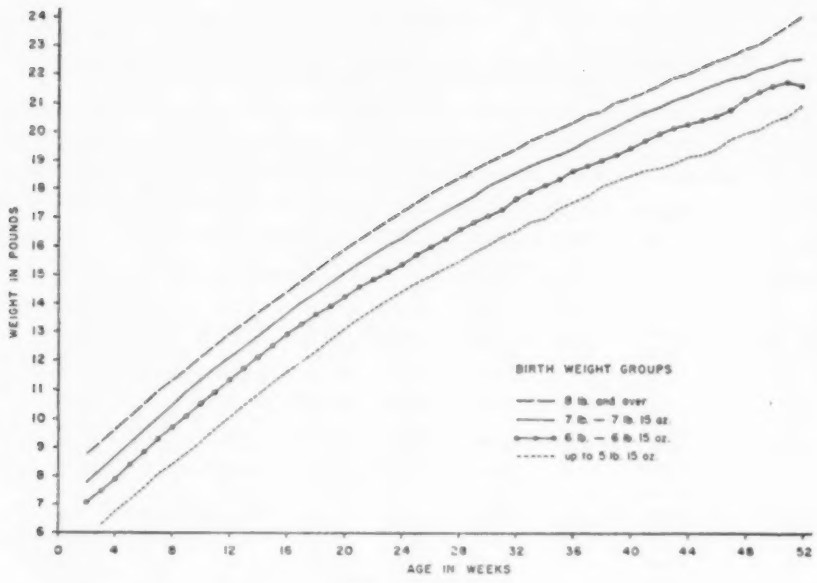

CHART 2.

GROWTH CURVES IN FIRST YEAR OF LIFE ACCORDING TO BIRTH WEIGHT (EUROPEAN BOYS SHOWING BIRTH WEIGHT GROUPS SEPARATELY).

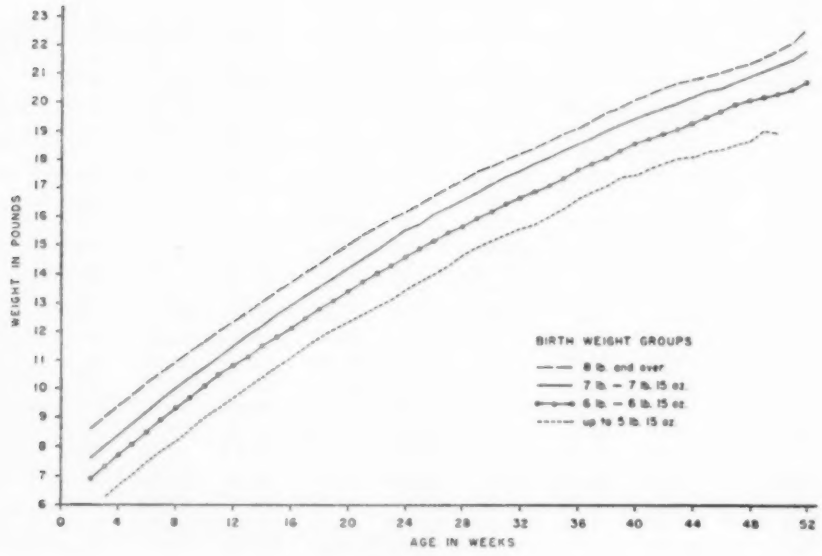

CHART 3.

GROWTH CURVES IN FIRST YEAR OF LIFE ACCORDING TO BIRTH WEIGHT (EUROPEAN GIRLS SHOWING BIRTH WEIGHT GROUPS SEPARATELY).

slightly exceeds that of girls at each age; relatively there is little difference between them (*i. e.*, in increases as a percentage of weight at the end of the preceding period).

Norval *et al.* ('51) state that boys are longer and heavier than girls of the same age, and boys are also heavier than girls of the same length. The growth rates of length and weight are somewhat larger for boys than girls at the beginning of the year, but approach equality by the end of the year.

Parfit ('51) compared average weights at successive age periods in the first year, and found a significant difference between the boys and girls, which progressed with age. At birth her boys were 4 oz heavier than girls, at 6 months 20 oz, and at the end of the year 26 oz. This showed that the difference in rate of gain which had started prenatally continued for at least 12 months. However, examination of her figures shows that in the early period the boys have grown much faster than later in the year.

On the whole certain facts can be deduced from the foregoing:

1. Mean weight of boys are greater than those of girls throughout the first year of life.

2. Rate of growth of boys is faster than that of girls throughout this period, but the difference in rate of growth is greater in the first 6 months of life than in the second 6 months.

The present investigation confirms these findings for European babies. European boys are about a pound heavier at the end of the year than European girls. They grow faster than the girls throughout the year, but the difference in their growth is greater in the first than the second 6 months of life.

The non-European pattern is rather different. Mean weights for boys are still greater than those for girls, Colored difference being slightly less than European, and Bantu and Indian less than Colored. Deviation from the usual pattern appears in the rate of growth.

If we express table 1 somewhat differently and compare the differences in weight of boys and girls at successive periods we see this quite clearly.

In Europeans boys always maintain a faster rate of growth than girls. In the other three groups in Colored and Bantu from 39–50 weeks and in Indians as early as 26–39 weeks this trend becomes reversed. In other words, in those periods girls are actually growing faster than boys. They do not catch up with the boys by 50 weeks, partly because

of the superior birth weight of the boys but the total gain of weight of Indian boys and girls is almost the same from 2–50 weeks and, if one can accept the 52 weeks figure, is actually greater than that of the boys from 2–52 weeks. Bantu still show a difference in favor of boys in total gain from 2–50 weeks of about ½ lb and Colored about 1 lb but there is no question of the direction of the growth and it would seem that if one could follow these children into the second year of life one might find the girls to be actually heavier than the boys.

TABLE 4

Comparison of weight differences of boys and girls at successive periods

	3–13 weeks (lb)	13–26 weeks (lb)	26–39 weeks (lb)	39–50 weeks (lb)
European	+.27	+.37	+.03	+.28
Colored	+.51	+.33	+.10	—.13
Bantu	+.47	+.20	+.34	—.46
Indian	+.34	+.67	—.47	—.33

\+ Boys grow more rapidly than girls.
— Boys grow less rapidly than girls.

Phillips ('53) in a study of South African nursery school children (European and Bantu) found that unlike the European, Bantu girls were superior in weight though not in height, to Bantu boys. He also quotes a study by Robertson ('52) where Bantu pre-school girls were heavier and taller than boys. Kark ('52) discussing Bantu school children in Pholela also found when he compared them with European, American, and White South African figures, that the Pholela boys were somewhat more retarded in stature and weight than the Pholela girls and had a higher incidence of clinical signs of malnutrition.

It would be most interesting to see whether the same remarks apply to Colored and Indian pre-school and school children, if the information were available, but even on Bantu data only, it is possible that girls start growing faster than boys from some point in the first year of life, and it is possible that the differences in rate of growth of Indian boys and girls would be found to be even greater if follow-up studies could be done.

The reason for this difference in growth rate in non-Europeans can only be speculative at this stage. We know that boys are biologically

inferior to girls at least as far as mortality rates are concerned. It is quite possible that in adverse conditions, girls do better than boys as far as growth is concerned. In this connection it is most interesting to see that the Indian infants whose diets and general rate of growth in the first year of life are the poorest of the four races, show the increased rate of growth of girls at an earlier age than that shown by the Bantu and the Colored.

Effect of Birth Rank on Growth.

Wardlaw and Dart ('32) remark on the unique position which the first born male of a family occupies in the social organization of many peoples, and are surprised that differences between first and later children are so infrequent in literature dealing with growth of children. "In the biblical writings there are, indeed, many instances in which the expression 'first born' is used to connote the possession of superior or outstanding qualities of some kind. But no clue is given to the nature of the qualities which the first born, in the literal sense, might be supposed to show. Any distinguishing qualities of the first born male which may exist have been obscured by the fact that only approximately half the total number of first born males are first children. The occurrence of first born female children is usually not taken into account."

A summary of their findings on the relationship between the weight of breast fed babies and their order of birth is as follows:

"The earlier infants of a moderate sized family tend to be lighter than those born later.

"For breast fed infants a similar relation between weight and order of birth holds up to an age of about six months.

"The growth of the infants of primiparae tends to be retarded more during the first four weeks of life than the growth of later children.

"The relatively heavier, later children of a family have available a more plentiful supply of breast milk than the earlier, lighter children."

Pearson ('14) states that "the growth of the first child is hampered by conditions which exist to a far less extent for the following births."

However, desipte this handicapping, there is evidence to suggest that first children grow better than later born children, at least in the first year of life.

Meredith ('50) reviewed the literature on birth order and body size.

He quoted Schmid-Monnard ('92) who found that the relationship between birth order and body weight became reversed during the first postnatal year. Children of "old pluriparae" were heavier in early infancy than those of "young primiparae" but the latter were heavier in the second half of the first year. Meredith concludes that the available evidence in late infancy and childhood shows that body weight is inversely related to birth order.

Hewitt and Stewart ('52) found that parity was an important source of variation in birth weight and subsequent weight gain. The birth weight of first born babies was distinctly below average, but by the end of the year these babies were slightly heavier than subsequent babies.

MacKinlay ('26) investigated working class families in slum areas of Glasgow. With regard to position of a child in the family and its weight and height, his findings were that infants of the first and those over the eighth pregnancy, were lighter and shorter than those of the in-between pregnancies. "The inferiority of the first born, however, is replaced at the end of the year by a definite superiority both in height and weight, while that manifested in the early months by the last born of families over eight is still apparent at the end of the year."

MacKinlay says that maternal morbidity is most frequent in first pregnancies and the high incidence of deformed pelves in a slum community magnifies the dangers of parturition. The difficulty and length of a first labor is associated with greater shock to first infants. But, as the age of the mother increases, and with it, the number of pregnancies, the environmental conditions change, and infants of later pregnanices may be born in over-crowded houses, in conditions of poverty and with exposure to infectious diseases more likely. First children, despite their low initial birth weight, may be expected to overcome their deficiencies if they receive good care, whereas later born childern, particularly in big families of low income, would of necessity get less care, and MacKinlay considers that the relationship of weight in infancy to the position of a child in the family is a secondary result of the efficiency with which the mother supervises her infant.

Hammond ('52) showed that later born children, especially girls, had a lower increase in weight in the first year. First born babies of both sexes gained more weight in the first year than the second, third and fourth born.

Cawley *et al.* ('54) also found positive correlations at birth between weight and birth rank (and between length and birth rank)—these

correlations were rapidly eliminated after birth and at two years had become negative. These authors agree with MacKinlay in attributing the reason for this negative correlation to be the association between place in family and socio-economic circumstances. First born children are more favorably placed than later born because well-off parents have small families and because poor parents are better off at the birth of their first children.

The present findings confirm the evidence that first born babies, although they start life with a lower birth weight, overtake later born babies and end up heavier at the end of the year. This result is found in both boys and girls.

Although data for non-European groups are insufficient for full analysis, the same results apply. In European, Colored and Indian babies, first born girls overtake later born earlier than first born boys overtake later born boys. In the Bantu the position is reversed for boys and girls. I can find no explanation for the difference in this respect.

Effect of Birth Weight on Growth.

Illingworth *et al.* ('49) demonstrated that birth weight had a constant and very important relationship to subsequent weight at all ages studied from 4–13 years. Throughout childhood the child who was small at birth weighed less than the child who was big at birth. Illingworth ('50) in another study of children up to three years of age, found that the same rule held. For example, his average male child who at birth weighed 9½ lbs or more, weighed more at one year than the child whose birth weight was 5½ lbs or less, weighed at two years.

Lowe and Gibson ('53) found the mean weight at the third birthday to be closely related to birth weight; the correlation between them (with birth order and duration of gestation held constant) being +0.49 for males and +.50 for females.

Drillien ('48) also found that at any given age (up to four years) average weight rose steadily with increasing birth weight.

Cullumbine ('53) investigating the health of a tropical people obtained the same results for the children of Ceylon. In one group of 327 children the weight at birth was positively correlated with the weight at 15 months, $r = +0.468$, at three years $r = +0.496$ and at 6 years $r = +0.423$.

Parfit ('51) found similar results in the first year of life—namely,

that children mantained their relative weight position at the end of the year according to their weight at birth. She makes the point, however, that the weight actually gained from birth was the same for babies of all birth weights. The rate of growth was greater for small babies than for large.

Similar conclusions on the lack of association between gain in weight and birth weight were reached by the Divisional Medical Officer, Lancashire County Council ('50), by Simpson ('52) and by Hammond ('52).

Norval *et al.* ('51) state that the observation of the weight at the end of the year being dependent on the weight at birth is a very old one, and quote Camerer who showed this as early as 1893. They make the point, however, that with the same amount of weight gain in two children, the smaller child will have a larger percentage increase in weight. They found additional evidence by correlating birth weight with absolute gain of weight during the year. In both boys and girls the regression was negative; that is, the amount of growth is larger for smaller children than for larger children.

Hill and Magee ('38) also agree that lighter babies have a relatively greater increase in weight gain than heavier babies. For instance, between the 4th and 28th week the lighter babies (male and female) rather more than doubled their birth weight, whereas the heavier group increased by 86%. Between the 28th and 52nd week the lighter group increased by 36% for males, 33% for females, and the heavier group by 27% and 31%, respectively.

Herdan ('54) says that the relationship between birth weight and subsequent weight is not constant but decreases with increasing age, which is to be expected since in the early stages of life body weight exceeds birth weight by only a small amount, but as weight increases with age, birth weight becomes relatively smaller and less important compared with additional weight after birth. At three years of age he assesses the effect of birth weight as accounting for not more than 25% of the variation in subsequent weight.

Thomson ('54) states that "it is wrong to say, and still worse to teach, that infants double and treble their birth weight at a fixed age." Thus he agrees with Parfit who made the same point in her investigation. The Divisional Medical Officer's Report referred to previously gives a table of expected weights at one year, which certainly shows this rule to be inaccurate.

Hahn ('55) found that two-thirds of the infants he surveyed com-

pleted the doubling time between 14 and 22 weeks (*i. e.*, 3–5 months). The figures in this study also suggest that babies, particularly those lighter at birth, double their birth weight before 6 months. Taking all ranks together, boys and girls separately, European boys double their birth weight by 20 weeks (girls 21 weeks) and treble their weights by the end of the year. Using birth weights for non-Europeans given by Salber and Bradshaw ('51) it can be seen that Colored boys double their birth weight by 18 weeks (girls 20 week), Bantu boys by 14 weeks (girls 15 weeks) and Indian boys by 15 weeks (girls 14 weeks). Only Bantu males and females, and Colored males, however, have succceeded in trebling their birth weight by one year.

SUMMARY

1. Boys' weights are higher than those of girls throughout the first year of life.
2. European boys grow consistently faster than girls in the first year.
3. Non-European boys grow faster than girls in the first 6–8 months of life, but the girls grow faster than the boys thereafter.
4. It is suggested that in adverse environmental conditions, girls grow better than boys.
5. First born babies of both sexes start off lighter than later born babies at birth, but overtake them during the first year.
6. In Europeans, Colored and Indians the difference in rate of growth between the ranks is greater for girls than for boys, but in the Bantu it is greater for boys.
7. Because of their superior birth weight heavy babies at birth remain heavier throughout the year than babies who are lighter at birth.
8. Birth weight has no effect on gain in weight during the year.
9. This means that rate of growth is relatively greater for babies who are lighter at birth.
10. Babies double their birth weight before 6 months of age. This applies particularly to lighter babies and to non-European babies.

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BOOK REVIEWS

The Longitudinal Study of Individual Development. By LELAND H. STOTT. 115 pp. The Merrill-Palmer School, Detroit, 1955. $2.75.

There are two basic approaches in studying growth and development: One is cross-sectional where large numbers of individuals are measured for some factor at a particular age; data so obtained provide information, usually in the form of 'norms,' on the status of this factor at certain fixed ages. The other is the longitudinal approach where the *same* individuals are measured and followed over a number of years. This approach to the study of growth is more satisfactory for it gives valuable information about individual variations in the growth patterns of children and, most of all, provides data on the velocity of development. Not everyone is convinced of the efficacy of the longitudinal approach, for such studies are expensive to run, large quantities of data are collected, some considerable time is often needed to await results, and it is not always easy to keep in contact with the same children. The fact remains that there are many problems which can only be studied longitudinally and it is necessary to fight for its use. In making a case for the advantages of the longitudinal study, one important aspect is often forgotten: this is its teaching value.

In writing this book, Dr. Stott clearly had this in mind. Training in Child Development offered at the Merrill-Palmer School requires the student to follow a particular child over a number of years. Emphasis is placed on the "whole child" and an attempt is made to study all general factors concerned in his development. Dr. Stott presents to the student various methods and techniques useful in evaluating this highly complex process. The most valuable feature of the book is that, in discussing the methodology in general, he emphasizes the necessity for critically evaluating the various techniques. The actual presentation of the techniques for appraising developmental status and progress is fair, clear, and concise.

At the outset Dr. Stott discusses the general considerations necessary in studying the child longitudinally and this includes an excellent, simply presented section on basic statistical concepts. Appraising developmental status is discussed and it is divided into physical, behavioral, social, emotional and mental developments, and the evaluation of personality. A

part of the book is given over to a description of the methods for tracing developmental progress and there is a clear general discussion on growth curves, both physical and mental.

Finally the author describes the factors that condition individual development, emphasizing the importance of the home and family environment and the necessity for its evaluation. There are 36 figures at the end of the book illustrating techniques; the references are adequate. The book is of a loose leaf type and is paper backed. The material is well presented and the printing clear.

Dr. Stott would be happy if his book stimulates even if we may criticize some of the tests and techniques. It certainly stimulated the reviewer and it can be strongly recommended to all students interested in the longitudinal approach in human biology.

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Biochemical Individuality: The basis for the genetotrophic concept. By ROGER J. WILLIAMS. xi + 214 pp. John Wiley, New York, 1956. $5.75.

This book is devoted to the discussion of the variability and individuality at the physiological and biochemical levels, with emphasis on what the author calls "genetotrophic" concept and its implications for the broad field of human biology. Some aspects have been discussed previously by the author in *The Human Frontier* (1946) and *Free and Unequal* (1953). The present volume is devoted in a more specific way to the implications of the concept for biology and medicine.

The idea of human variability has been present in the mind of physicians since Hippocrates, and the growth of medical knowledge has been continuously showing the importance of individaul characteristics in the genesis and course of disease in man. The development of "constitutional pathology" represents an attempt to establish the significance of such differences (cf. G. Draper, *Human Constitution in Clinical Medicine*, 1944).

The genetotrophic principle as conceived by the author postulates that every organism, with its distinctive genetic background, has also distinctive nutritional needs that must be met for optimal well-being.

The concept gives scientific support, based on the present biochemical knowledge, to some old observations. The popular dictum "One man's food is another man's poison" is a good expression of this idea. Much the same thought has been expressed by no lesser food expert than Brillat-Savarin, who said: "Tell me what you eat, and I'll tell you what you are."

The genetotrophic concept affects human biology in two main ways: (1) It calls attention to the significance of biochemical differences between "normal" individuals, and to their genetic basis; (2) it makes possible the correction of these differences by adequate food supply, should they be of consequence in the development of pathological conditions. In this last aspect the concept has obvious importance both for clinical and preventive medicine. The author considered the implications for the biological sciences, medical and dental research, and for psychiatry.

Biochemical Individuality is a readable book, full of interesting information. Data concerning human variability in anatomical, physiological, biochemical (composition of fluids and tissues, enzymic patterns, endocrine activities, excretion) and pharmacological characteristics are given and analyzed. It is possible that not all the variations considered will be strictly genetically controlled but this will not detract from the general validity of the argument. There is no doubt about the potential salutary effect on medical progress of the emphasis on individual differences.

It is clear that in this type of book the theoretical development of the argument is more important that the details of the factual material. However, it is felt by this reviewer that some loose statements, such as the one on page 49 concerning the estimation of the "intracellular" water, could have been avoided. Individuals differ markedly in their gross body composition. This information, much of which was accumulated in the last 10 years, deserves perhaps more attention in considerations of the extent and significance of differences between individuals than has been given it by the author.

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Physiological Psychology. By M. A. WENGER, F. N. JONES and M. H. JONES. viii + 472 pp. Henry Holt, New York, 1956. $6.00.

Life Stress and Essential Hypertension: A Study of the Circulatory Adjustments in Man. By STEWART WOLF, PHILIPPE V. CARDON, EDWARD M. SHEPARD, and HAROLD G. WOLFF. ix + 253 pp. Williams and Wilkins, Baltimore, 1955. $7.50.

In many respects the two volumes are very different, the one being an introductory textbook, the other a monograph. Yet, their points of view complement each other. Wenger *et al.* stress that psychology is fundamentally a biological science and they present psychobiology (psychophysiology) as a cornerstone of the science of behavior. The largest amount of space is devoted to well established physiological facts concerning nervous function, hormones, special senses, motion and complex (integrated) behavior. The more "psychological" topics include learning, motivation and emotion. The interactions between mental (cortical) activity and other bodily functions are considered under the headings of somatopsychics (psychological effects of somatic factors) and psychosomatics (psychogenic changes in somatic functions).

Emotion is viewed broadly (probably too broadly) as visceral action, as activity and reactivity of the tissues and organs innervated by the autonomic nervous system which may involve, but does not necessarily involve, skeletal muscular responses or mental activity (p. 343). According to the authors' definition, exercise would also be classified as emotion, since it involves altered activity of the autonomic nervous system.

The final chapter is devoted to problems considered as important targets of research. Many of these are largely the concern of the physiologist. The true realm of psychophysiology, in the reviewer's opinion, is defined by the interaction between physicochemical processes in the organism and behavior. The authors define psychophysiology in broader terms but they, too, believe that many fundamental problems in the study of behavior will not be solved until a "meeting of minds," trained both in biochemistry (and physiology) and in psychology, will take place.

Wolf *et al.* brought together the results of some 10 years of study on circulatory adjustments to varying life experiences. The investigations were carried out for the most part in a special clinic of the

Cornell University Medical College. The course of events in the patients' day-to-day life, their changing attitudes and reactions were examined in reference to the occurrence of symptoms of cardiovascular disturbances. The "stress interview," in which emotionally charged topics were introduced into the conversation while alterations in cardiovascular function were being recorded, served as means for bringing up meaningful, especially threatening, life situations for experimental study.

Reduction of exercise tolerance, evaluated in terms of pulse rate as well as ballistocardiographic and electrocardiographic criteria, was noted in patients with neurocirculatory asthenia during situations provocative of anxiety or anger. Circulatory adjustments involving rhythm of the heart and peripheral blood vessels were examined but the studies were focussed on sustained elevation of blood pressure, without coming to definitive conclusions regarding the role of stress in the pathogenesis of essential hypertension. Nevertheless, the authors believe that the available evidence warrants clinicians' interest in the background, life experiences and attitudes of the patient with essential hypertension and the effort to help him to make a more adequate personal adjustment. In summary, "Not only may the hemodynamic changes characteristic of hypertension, including a reduction in renal blood flow, be induced for short periods in suitably susceptible persons by the contemplation of stressful life experiences, but long-term variations in blood pressure level have been repeatedly correlated with periods of stress. Moreover, the data indicate that the course of essential hypertension may be mitigated by measures directed at enhancing the satisfactions and improving the adjustment of the individual."

The pressor mechanisms accounting for essential hypertension remain obscure. It is suggested that the initial response to emotional stress may provoke renal ischemia which may in turn set off humoral mechanisms which cause ultimately irreversible tissue damage. In reference to personality, the hypertensive patients were characterized as "inclined to be tentative and wary, fundamentally driving and often hostile but unable fully to commit or assert themselves." Encouragement of a freer, more fearless self-assertion and of wholehearted commitments was recommended as a part of therapy.

The data are presented largely in the form of case studies, using numerous quantitative criteria of cardiovascular function. Rigorous experimental studies of the effects of life stress are difficult and the

authors are properly cautious in their conclusions concerning etiology and treatment of essential hypertension. However, the profound effects of actual or symbolically represented "stressful" events were documented amply and convincingly.

The description of the cardiovascular effects of emotional stresses has been quite elaborate, and the characterization of the responses leaves little to be desired. The segment which may profitably receive emphasis in future research is the nervous system itself (encephalogram under normal conditions, motor and sensory chronaxies, and other physiological indicators of functional status) and the responses to controlled physiological stimuli (such as direct and conditioned vascular reflexes to heat and cold, or changes in the electroencephalogram under conditions of physiological stress). Dr. E. Simonson, of this Laboratory, pointed out to the reviewer the surprising scarcity in this country of neurophysiologically oriented studies on alterations in the nervous function in man, especially during the initial phase of essential hypertension. Useful and more detailed information on function changes in the central and autonomic nervous system could be obtained in animals with certain types of experimentally induced hypertension.

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BOOK NOTICES

AN INTRODUCTION TO CYBERNETICS. By W. Ross Ashby. ix + 295 pp. John Wiley, New York, 1956. $6.50. Directed to workers in biological and behavioral sciences, the book "starts from commonplace and well-understood concepts, and proceeds, step by step, to show how these concepts can be made exact, and how they can be developed until they lead into such subjects as feedback, stability, regulation, ultrastability, information, coding, noise, and other cybernetic topics."

ANTHROPOLOGISCHER ANZEIGER, Vol. 20. Edited by W. Gieseler and E. Breitinger. E. Schweizerbart, Stuttgart, 1956. Revived after a period of some 12 years, this useful journal continues the tradition of publishing detailed bibliographies, reviews, brief original papers and news, including obituaries.

PROGRESS IN NUCLEAR ENERGY, SERIES SEVEN: MEDICAL SCIENCES, Vol. I. Edited by J. C. Bugher, J. Coursaget, and J. F. Loutit. xii + 165 pp. McGraw-Hill, New York, 1956. $6.00. The use of tracer techniques in the study of the workings of the body was described in a volume published in series VI (Biological Sciences) of this comprehensive survey. The present publication deals with problems of medical diagnosis, investigation of disease processes, therapy, safety, and the determination of absorbed doses of radiation.

WEST HIGHLAND SURVEY. Edited by F. Fraser Darling. xvi + 438 pp. Oxford University Press, New York, 1955. $4.80. A detailed account of a comprehensive social and biological investigation of an area of Scotland suffering from depopulation and economic decline. Eighty pages are devoted to population study.

THE STRESS OF LIFE. By Hans Selye. xvi + 324 pp. McGraw-Hill, New York, 1956. $5.95. A readable presentation of the concept of "stress" (the common denominator of adaptive reactions in the body), its mechanisms in health and disease, and its theoretical as well as practical (medical, psychosomatic, philosophical) implications.

PHYSICS, PSYCHOLOGY, AND MEDICINE. By J. H. Woodger. x + 145 pp. Cambridge University Press, 1956. $1.75. The essays are focussed on the neglect of psychology in medical curriculum, ascribed to the enormous success and consequent prestige of the physical sciences. Special attention is given to the linguistic apparatus of medical psychology.

CHILD DEVELOPMENT. By Elizabeth B. Hurlock. xvi + 703 pp. McGraw-Hill, New York, 1956. $6.00. Third edition, revised and largely rewritten. The presentation of the history of child psychology was replaced by a chapter on social adjustment. Contains a chapter on physical growth. Large bibliography (80 pp., alphabetic). Lists visual aids. Correlated with films.

THE BIOLOGY OF SENESCENCE. By Alex Comfort. xiii + 257 pp. Rinehart and Co., New York, 1956. $4.00. A survey of literature (over 800 references) concerned with the nature and criteria of senescence in animals, longevity and inheritance of life span, growth and senescence, and the role of cellular and endocrinological changes. Man is considered, for the most part, only incidentally.

MAN, CULTURE, AND SOCIETY. Edited by Harry L. Shapiro. xiii + 380 pp. Oxford University Press, New York, 1956. $7.50. A presentation of basic anthropology for the general reader or the beginning student. The book consists of 16 chapters contributed by outstanding scholars. "Human Beginnings" is the only chapter concerned with physical anthropology.

STUDIES IN TOPECTOMY. Edited by Nolan Lewis, Carney Landis, and H. E. King. vii + 248 pp. Grune and Stratton, New York, 1956. A series of studies designed to explore the potentialities of psychosurgical methods as a therapy for mental disorders, and to investigate the role of the frontal lobes of the brain in human behavior. Covers the whole spectrum of problems, from surgical procedures to physiological, psychological, and psychiatric effects and social adjustment.

THE HAZARDS TO MEN IN SHIPS LOST AT SEA, 1940-44. By R. A. McCance, C. C. Ungley, J. W. L. Crosfill, and E. M. Widdowson. v + 44 pp. Her Majesty's Stationery Office, London, 1956. $.60. Summarizes data obtained from men who survived the loss of their ships. Cold appears to be "the greatest hazard facing men adrift in open boats. Lack of fresh water became an important cause of death on the longer voyages, and the effects of drinking seawater seem to have been almost invariably disastrous."

LYSERGIC ACID DIETHYLAMIDE AND MESCALINE IN EXPERIMENTAL PSYCHIATRY. Edited by Louis Cholden. xi + 85 pp. Grune and Stratton, New York, 1956. $3.00. Proceedings of a roundtable conference held at the annual meeting of the American Psychiatric Association. The setting was described by the editor: "The key to understanding psychiatry's deepest mystery, schizophrenia, might lie in the production of an experimental, predictable, controllable, reproducible state—an artificial psychosis. Such are the hopes that some investigators hold for the state of mind induced by giving lysergic acid diethylamide (LSD)."

WORK, WORKERS, AND WORK MEASUREMENT. By Adam Abruzzi. xvi + 318 pp. Columbia University Press, New York, 1956. $7.50. A fresh presentation of the human aspects of industrial engineering, with standardization and production rates as the focal concepts. Problems of fatigue are considered briefly.

LEARNING AND INSTINCT IN ANIMALS. By W. H. Thorpe. viii + 491 pp. Harvard University Press, Cambridge, Mass., 1956. $10.00. Attempts to provide a synthesis of studies on instinct and learning. Different types of learining are discussed and the learning abilities of the main animal groups are surveyed. One of the major objectives of the book has been "to point out

to psychologists and learning theorists on the one hand and to zoologists and physiologists on the other how dependent each is, or ought to be, on the work and viewpoint of the other."

THE FUTURE OF ARID LANDS. Edited by Gilbert F. White. ix + 453 pp. American Association for the Advancement of Science, Washington, D. C., 1956. $6.75. Thirty-odd papers plus recommendations from international arid-lands meetings. A multidisciplinary effort to assess the present state of man's struggle to make productive use of large areas of the world characterized by meager or undependable rainfall.

STATISTICS, A NEW APPROACH. By W. Allen Wallis and Harry V. Roberts. xxxviii + 646 pp. Free Press, Glencoe, Illinois, 1956. $6.00. Statistics is defined as "a body of methods for making wise decisions in the face of uncertainty." Intended as a textbook for beginners, it will be found helpful and refreshing. Hear ye, hear ye: "Sometimes authors are so intrigued by tests of significance that they fail to state the actual *amount* of the effect, much less to appraise its practical importance."

PROCEEDINGS OF THE WORLD POPULATION CONFERENCE, 1954. iv + 276 pp. United Nations Department of Economic and Social Affairs, New York, 1955. The meetings were held in Rome under the auspices of the United Nations. The papers presented at the conferences were published in 6 volumes. The Summary Report describes the organization of the conference and its program and presents summaries of the 32 meetings.

POPULATION GENETICS: THE NATURE AND CAUSES OF GENETIC VARIABILITY IN POPULATIONS. Cold Spring Harbor Symposia on Quantitative Biology, Volume 20. xvi + 346 pp. Biological Laboratory, Cold Spring Harbor, New York. $8.00. The primary objective of this important symposium was to bring together the evolutionary and the agricultural geneticists in an effort to establish agreement on fundamental concepts. Of special interest is T. Dobzhansky's introductory review, the sections on general population genetics theory and on quantitative genetics, and A. C. Allison's chapter on some aspects of polymorphism in man.

BODY MEASUREMENTS AND HUMAN NUTRITION. Edited by Josef Brožek. Wayne University Press, 1956. v + 167 pp. $3.50. A reprint, with the addition of editor's preface and an index, of the proceedings of the Conference on the Role of Body Measurements in the Evaluation of Human Nutrition, sponsored by the Committee on Nutritional Anthropometry, Food and Nutrition Board, National Research Council, and held at Harvard University, Cambridge, Massachusetts, June 17 and 18, 1955. The proceedings were originally published in the May, 1956 issue of *Human Biology* (Vol. 28, No. 2).

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